United States Court of Appeals

for the Second Circuit

APPENDIX

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NO. 74-2284 et al.

Nos. 74-2284, 74-2286, 74-2308, 74-2450, 74-2449

JOINT APPENDIX TO THE BRIEFS

VOLUME II

IN THE UNITED STATES COURT OF APPEALS
FOR THE SECOND CIRCUIT

THE SOCIETY OF THE PLASTICS INDUSTRY, INC.,

HOOKER CHEMICALS & PLASTICS CORP.,

UNION CARBIDE CORPORATION,

TENNECO CHEMICALS, INC.

and

AIR PRODUCTS AND CHEMICALS, INC.,

Petitioners,

v.

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION,
UNITED STATES DEPARTMENT OF LABOR;
PETER J. BRENNAN, SECRETARY, DEPARTMENT OF LABOR;
and JOHN H. STENDER, ASSISTANT SECRETARY
FOR OCCUPATIONAL SAFETY AND HEALTH,

Respondents.

On Petition For Review Of An Order Of
The Occupational Safety and Health Administration,
United States Department of Labor

UNITED STATES COURT OF APPEALS
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2ND CIRCUIT

Submitted by:
MARTIN I. SHELTON
Shea Gould Climenko & Kramer
330 Madison Avenue
New York, New York 10017

Attorney for The Society of
the Plastics Industry, Inc.

Prepared by:
ALLAN J. TOPOL
JONATHAN M. WEISGALL
Covington & Burling
888 Sixteenth Street, N.W.
Washington, D.C. 20006

Attorneys for Hooker Chemicals
& Plastics Corp., Tenneco
Chemicals, Inc., and Air
Products and Chemicals, Inc.

November 12, 1974

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EX 18B

Mortality Experience of a Cohort of Vinyl Chloride-Polyvinyl Chloride Workers*

430

by

William J. Nicholson, Ph.D., E. Cuyler Hammond, Sc.D., Herbert Seidman, M.B.A. and Irving J. Selikoff, M.D.

Since the publication on January 24th, in the Wall Street Journal, of three deaths from hemangiosarcoma of the liver in polyvinyl chloride production workers at the B.F. Goodrich facility in Louisville, considerable data of scientific interest have been forthcoming. The data include the results of ongoing animal experimentation,[1] some clinical results on working populations,[2-5] and reports of other cases or deaths from liver hemangiosarcoma in vinyl chloride-exposed workers.[6] A remarkable amount has been accomplished in a short three-and-a-half-month period. However, to fully define the extent of the health problem associated with vinyl chloride exposure, it is clear that epidemiological approaches must be extended to include many individuals observed over sufficiently long periods of time to allow the full scope of any excess disease to be manifest.

While studies on the causes of death of exposed individuals offer the possibility of obtaining much more useful information, one must recognize the existence of several limitations. Firstly, they are difficult and time-consuming to accomplish; one must trace and determine the status of all individuals having a defined exposure. This presents no difficulty for those workers still employed or retired and receiving company pensions. However, many individuals will have left the employ of a company prior to retirement and must be traced in order to obtain complete data. Secondly, sufficiently long follow-ups of exposed individuals must be completed. In other circumstances, it has been shown that occupationally induced cancers may take 20, 30, even 40 years before appearing in populations at risk. Thus, studies conducted over a short follow-up period may be misleading in that they are dominated by causes of death unrelated to the worker's exposures. Thirdly, sufficiently large numbers of workers must be included in such studies to allow meaningful statistical considerations to be applied, particularly in causes of death that are found relatively frequently in the general population. Fourthly, in such studies it is most desirable to have accurate information on vinyl chloride levels to which individuals in the cohort were exposed.

At this time, unfortunately, the relatively recent use of vinyl chloride does not allow us the luxury of having each, or even any, of the preceding four

*This study was supported by Grant ES 00928 of the National Institute of Environmental Health Sciences, of the Department of Health, Education and Welfare.

criteria satisfactorily fulfilled. Nevertheless, the urgency of the health problem resulting from past vinyl chloride exposures requires that all available preliminary data be scrutinized. Thus, an initial cohort study of vinyl chloride-polyvinyl chloride workers was undertaken at a major production facility.

Utilizing Union and Company records, a cohort of 257 individuals has been established, each of whom had been occupationally exposed to vinyl chloride for at least five years subsequent to 1946 in a polyvinyl chloride polymerization facility, having begun employment in the period 1946 - 1963.* This included all individuals so employed in this plant during this time. We have determined the mortality status of these individuals from the tenth anniversary of their employment through April, 1974. The five-year exposure criterion was established for this preliminary study in order that the effects of significant exposures be established. The criterion that observations would begin only after ten years from onset was selected so that one might focus on the long-term effects of vinyl chloride exposure. While the exposures began in 1946, only a relatively few individuals were employed prior to 1951, when a significant increase in the work force took place. Thus, the majority of the cohort had a bare 20 years or less from onset of exposure.

The initial production facility consisted of six vinyl chloride monomer reaction vessels, a polymerization complex of four reactors, and a building for drying and bagging operations. From 1946 through 1950, seven men and one supervisor per shift handled the operations in all three areas. Thus, the production work force was approximately 30 men. In 1951, a significant expansion took place in the production facility; 16 additional polymerization reaction vessels and 12 monomer reactors were installed. The work force at this time expanded to approximately 150 hourly employees in the vinyl chloride and polyvinyl chloride operations. The only other significant change in this manufacturing complex came in 1960, when the production of the vinyl chloride monomer ceased, due to the local unavailability of raw materials. From that point on, the vinyl chloride was received in tank cars from Texas. Little change occurred in the total work force, however.

Of the 257 individuals exposed since 1946, 255 have been traced and their current health status established. Of the 255 so traced, work histories and, to a large extent, medical histories, have been documented. Table 1 shows a summary of their work activity during their first ten years of employment in the PVC production facility. The majority of the 255 were employed directly in production. Typically, the first job of a newly-hired individual would be the bagging

*We are grateful to the Goodyear Tire and Rubber Company and to Local 8-277 of the Oil, Chemical and Atomic Workers Union for their cooperation in this tracing.

of the resin for shipment. During the course of this work, he would be periodically assigned to reactor cleaning or drying machine operation duty. Such cleaning operations were required weekly for each polymerization reactor and were routinely done without benefit of respiratory protection. As a man gained seniority he could be transferred to the reactor operations. In this job, he would be concerned with the operation and control of the polymerization process. On overtime, however, he might also be asked to engage in reactor cleaning operations. Additionally, whenever leaks or accidental releases of vinyl chloride occurred in the reactor area, the possibility of high exposure existed.

Nearly one quarter of the individuals were employed predominantly in the maintenance department. Here, individuals would be assigned to correct mechanical problems anywhere in the plant. During times of mechanical breakdown in the reactor facility, their exposure to vinyl chloride could be significant. In general, however, this group would not experience extremely high exposures as often as those who would have engaged periodically in reactor cleaning. Parenthetically, one should note that a portion of the work experience of maintenance personnel may have been as production operators, but, in these cases, it would total less than five years.

A third group with lesser exposure was that of 26 men in the shipping department. Here, exposures were to gases that may evolve from the dried resin and from vinyl chloride released in other areas of the plant. A fourth group of 18 individuals, also with a lower exposure, was composed of laboratory personnel, testing the quality of both incoming chemicals and outgoing products. Because of the small number of individuals in the latter two groups, it was not practical to separately analyze their experience. They are thus included as part of a total cohort of individuals exposed to vinyl chloride in this one plant, although they may dilute somewhat the experiences of individuals with high exposures. We have excluded from consideration in this cohort individuals who were employed exclusively as plant guards or who worked outside the reactor and dryer buildings.

No data exist as to the levels to which these individuals may have been exposed in past years. Generally, measurements that were made prior to 1972 were to assure that the explosive limit of vinyl chloride was not exceeded in plant operations. As this limit exceeds 30,000 ppm, it has little relevance to current consideration of health effects.

In reviewing work practices and clinical symptoms experienced by individuals in the plant, it is clear that vinyl chloride concentrations could have been extremely high. Although reactors were purged at 20 inches of vacuum for up to

20 minutes prior to opening, a considerable amount of unreacted monomer could remain in the vessels. This was removed by insertion of an exhaust hose through the manhole cover to the bottom of the reactor vessel. The air pumped from the vessel was usually vented into the reactor room. The highest exposures occurred during cleaning when a man entered into the reactor to scrape the polyvinyl chloride resin from the walls and agitator; and unreacted monomer was released. Some data on the degree of exposure can be obtained from information provided by the employees during physical examinations of the current and past employees conducted in March of 1974. Over 50% of a group of current and past employees experienced symptoms of dizziness, headache or euphoria during work periods, and 14 out of 354 experienced concentrations sufficient to have caused loss of consciousness.[2] Thus, peak exposures may often have exceeded 1,000 ppm and, during acute episodes, may have approached 10,000 ppm in the production facility.

Table 2 shows the age distribution of individuals in this cohort as they entered the period of observation, that is, on the tenth anniversary of their employment in the production facility. As one can see, it was a relatively young group and one in which little disease and few deaths would be expected to occur. Over 50% of the men were under age 37 as they entered the cohort.

Information on the current status of the 257 individuals in the cohort is shown in Table 3. Over half are presently employed in the polyvinyl chloride production facility, although not all in areas with vinyl chloride exposure. 82 individuals working elsewhere or retired were interviewed as to their current and past employment, current health, smoking habits, and alcoholic consumption. This was done to verify exposure history and obtain information required for future prospective observation. 170 individuals in the total group were examined.[2] 24 individuals were found to have died and two are as yet untraced.*

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* Contact was made with individuals in Florida, California, Louisiana, Colorado and many other states and Canada; all told, 24 of the 82 individuals traced were found alive in states other than New York. In accomplishing the tracing of over 99% of the cohort in less than two months, we owe an enormous debt to the members of the Oil, Chemical and Atomic Workers, Local 8-277, as all individuals were traced directly through personal information obtained from Union members. In particular, we would also like to acknowledge the considerable time and effort put into this tracing by Mr. Ben Critelli, formerly of Local 8-277, and Mr. Frank Damon, of the Environmental Sciences Laboratory.

Table 4 shows the expected and observed total mortality and mortality from cancer in different periods of time since first exposure to vinyl chloride for the group of 255 individuals traced for the study. Although observations are limited, the excess in total mortality and in deaths from cancer is unusual, considering the relatively short period of follow-up in this study. The specific causes of death are listed in Table 5. Of the 24 deaths, three were due to hemangiosarcoma of the liver.[6] Each has been examined and characterized by Dr. Hans Popper and Dr. Louis B. Thomas of the National Cancer Institute and is included among other tabulations of hemangiosarcoma presented at this conference.[7] Additionally, one death was due to bleeding esophageal varices consequent upon cirrhosis of the liver. Information solicited from relatives and fellow workers concerning the individual's drinking history indicate only very modest alcohol consumption and suggest that this case, too, may be causally related to the individual's exposure to vinyl chloride. Among the other cancers resulting in death were one glioblastoma, a lymphosarcoma and a reticulum cell sarcoma. Our observation of a brain tumor and two lymphomas conforms to observations in other vinyl chloride-exposed populations[8] and suggests the possibility that their origin may also be related to vinyl chloride exposures. In addition to the above, three other malignancies were the underlying causes of death in this group of 24 workers.

The details of the work histories of the three workers who died of hemangiosarcoma and the other possible occupationally related cancers appear in Table 6. All but two worked extensively in the polymerization facility.

All of the hemangiosarcomas occurred in individuals who first worked prior to 1951. As the time from onset of exposure increases in cohort members with similar exposures, it may be that additional cases of occupational cancer will occur in this group of workers.

In summary: These data are derived from early follow-up of individuals exposed for five years to vinyl chloride in a polymerization facility. At least 17% of the deaths that occurred were causally related to exposure to vinyl chloride. Longer periods of observation are required to provide information concerning the full spectrum of vinyl choride induced malignancies, and their incidence among exposed workers.

These data speak for the need to prevent exposure to vinyl chloride and for surveillance and early disease detection of those who have experienced vinyl chloride exposures in the past.

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Table 1

Major Work Activity of 255 Individuals During First 10 Years of VC Exposure

PVC Production (reactor operation, reactor cleaning, PVC resin bagging)	151
Maintenance	60
Shipping	26
Laboratory	18
Total	255

Table 2

Age at Entry into Study Cohort
(at 10 Years from First Employment)

Age	Number of Individuals
25-29.9	42
30-34.9	64
35-39.9	60
40-44.9	29
45-49.9	32
50-51-9	15
55-59.9	9
60-64.9	2
65-69.9	2

Table 3

Status of 257 Individuals
Exposed to Vinyl Chloride for more than 5 Years
Starting between 7.1.1946 and 12.31.1963

	Examined and Interviewed	Interviewed	Deceased	Untraced	Total
Working at PVC Production Facility	139	10	--	--	149
Working Elsewhere	18	43	--	--	61
Retired	13	8	--	--	21
Deceased	--	--	24	--	24
Untraced	--	--	--	2	2
Total	170	61	24	2	257

Status recorded as of April 30, 1974.

Table 4

Expected and Observed Deaths From Various Causes Among 255 Workers Exposed to Vinyl Chloride for 5 Years Starting Between 7.1.1946 and 12.31.1963

	Years Since First Exposure									
	10-14.9		15-19.9		20-24.9		25-29.9		Total	
Person Years At Risk	1175		790		375		69		2410	
Cause of Death	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.
All Causes	6.1	10	6.6	7	5.0	7	1.3	0	19.0	24
All Cancer	1.2	3	1.4	3	1.1	3	0.3	0	3.9	9

Table 5

Causes of Death Among 24 Workers
Exposed to Vinyl Chloride for 5 or More Years

Cancer of all sites		9
Hemangiosarcoma of Liver	3	
Neoplasms of Lymphatic and Hemantopoietic Tissues	2	
Brain (Glioblastoma)	1	
Pancreas	1	
Colon	1	
Bone	1	
Cirrhosis (with esophageal varices)		1
Post-Operative Bleeding (Cholelithiasis)		1
Cardiovascular Diseases		13

Table 6

Work Histories of Individuals Dying of Selected Causes

Cause of Death	Date of Onset	Date of Death	Age at Death	Years of Exposure	Years Since First Exposure	Department
Hemangiosarcoma	10-46	03-70	60	23	23	PVC Production
Hemangiosarcoma	10-47	08-61	41	14	14	PVC Production
Hemangiosarcoma	06-51	05-68	54	17	17	PVC Production
Bleeding Esophageal Varices	06-54	11-65	39	11	11	PVC Production
Glioblastoma	11-52	04-68	68	12	15	Maintenance
Reticulum Cell Sarcoma	08-52	03-68	34	2 5	16	PVC Production Maintenance
Lymphosarcoma	05-58	04-70	32	12	12	PVC Production

Department of Labor, Washington, D.C.
June 25, 1974

EX 13 C

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Statement of Dr. Irving J. Selikoff* at hearing on Standard for control of vinyl chloride hazards

A little over four months ago, the Department of Labor conducted hearings for an emergency standard for vinyl chloride. I suggest that it is a tribute to scientists in our country and elsewhere, to the responsible government agencies, particularly the National Institute for Occupational Safety and Health, to many leaders of labor unions representing workers at risk of vinyl chloride-associated disease and to equally concerned leaders of the plastics industry, that an extraordinary amount of information has been gathered and analyzed in the weeks that have passed, information which now allows us to better judge the difficulties we face and to consider the steps that need be taken for their correction and control.

I would pay particular tribute to Dr. Marcus M. Key, Director of NIOSH, who rapidly deployed the limited resources at his disposal, in a manner which almost made us forget how scant and how few these were; to Dr. Joseph K. Wagoner and Dr. William J. Lloyd of his staff, whose total dedication and diligence was perhaps responsible for this impression and to Mr. Vernon Rose whose industrial hygiene efforts demonstrated professionalism at its best; and to their colleagues in NIOSH whose support made their efforts so fruitful. I call attention to the careful, continuous and detailed efforts of Dr. Clark Heath, Jr. and Dr. Henry Falk and their colleagues of the Communicable Disease Center in Atlanta, whose parallel and supplementary help to NIOSH was so notable; to Dr. Hans Popper and Dr. Louis B. Thomas of the National Institues of Health, whose brilliant and authoritative pathological interpretations provided scientific bedrock for the developing clinical, experimental and epidemiological studies. It is difficult to overestimate their contribution. Not only did they quickly establish the characteristics of

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*Professor of Medicine, Mount Sinai School of Medicine of the City University of New York; Director, Environmental Sciences Laboratory, Mount Sinai School of Medicine; Co-Chairman, Working Group on Toxicity of Vinyl Chloride-Polyvinyl Chloride, New York Academy of Sciences

the liver angiosarcomas which were found among vinyl chloride workers, but they have established much of the spectrum of associated liver disease which promises to help explain the mechanism of the injury we see and give guidelines for its clinical management and treatment.

I cannot refrain from proudly pointing to my many scientific colleagues who, starting almost from scratch, have been able to rapidly develop a very large amount of clinical, epidemiological, toxicological and experimental data, which now forms a secure background against which our discussions today take place. Here, colleagues from abroad have provided much help, including Dr. Maltoni of Italy, Dr. Lelbach, Dr. Marsteller, Dr. Veltman, Dr. Lange, Dr. Gedigk, Dr. Volkheimer, Dr. Muller, Dr. Jühe and others in Germany, Dr. Suciu of Romania, Dr. Sakebe of Japan and others of our colleagues abroad, as well as a phalanx of capable American scientists, including Dr. Creech, Dr. Jaeger, Dr. Gehring and Dr. Rowe, Dr. Berk and others in this country, including my colleagues at Mount Sinai, Dr.Nicholson, Dr. Hammond, Dr. Lilis, Dr. Daum, Dr. Anderson, Dr. Fischbein, Dr. Frank and Dr. Oster.

Perhaps it is a sign of the times that there have been so many valuable contributions by both labor and industry, where the help afforded by Dr. Johnson of Goodrich and Dr. Johnson of Goodyear was merged with the drive of Mr. Beliczky of the Rubber Workers and Mr. Mazzocchi of the Oil, Chemical and Atomic Workers, where the judgment of Mr. Vittone was matched by that of Mr. Clayman, where the Chemical Workers, the Steel Workers, the Machinists and other Unions rank side by side with Firestone, Tenneco, Dow and similar companies.

One explanation for the intensity of the effort and breadth of its application is that the vinyl chloride problem is neither peripheral nor esoteric, but central to major U.S. industry. There was unspoken recognition from the announcement of the first three cases of angiosarcoma of the liver at the B.F. Goodrich plant in Louisville, Kentucky, that we might be dealing with, not a rare disease of some 1,500 vinyl chloride monomer production workers and 5,000 polyvinyl chloride polymerization workers, but with conceivably many hundreds of thousands polyvinyl

production workers, fashioning this useful plastic into thousands of products -- and possibly exposed to varying levels of residual vinyl chloride monomer while doing so. We have learned from beryllium and from asbestos, that the hazard might not stop at the factory gate but that it might invade workers' homes and the neighborhoods about vinyl chloride-polyvinyl chloride facilities, that transport and storage might present unsuspected risks. The National Institute of Environmental Health Sciences joined NIOSH and the Occupational Safety and Health Administration in studying the dimensions of the problem.

Because of these achievements, I am optimistic that we will be able to control vinyl chloride hazards, that the extensive and important industry based upon use of polyvinyl chloride will continue to flourish and expand -- at least, as far as our petroleum supplies allow us to. However, I would immediately add an important condition. The critical constraint is that we eliminate health hazards associated with production of the monomer, its polymerization and the use of the polymer. It is unlikely that the curious calm which enveloped vinyl chloride toxicity for 25 years will in any way continue. Marsteller of Bonn, speaking at the New York Academy of Sciences meeting on May 10, found it "quite remarkable" that the Russian report of liver damage in 1949, in more than 25% of a group of vinyl chloride workers, was only marginally mentioned subsequently and he noted further that even after 1961, when four research groups presented their results on chronic toxicity of vinyl chloride, continuing large scale studies were not undertaken and the importance of the observations seemed underrated even by the authors themselves. Perhaps the most graphic description has been in the title in a leading article in the New Scientist of June 13, 1974, which read "Science paused -- and 17 died". The central issue, then, is control and elimination of vinyl chloride health hazards, particularly the neoplasms which have been discovered associated with vinyl chloride exposure. During these four days of hearings, it is likely that many aspects of the problem will be examined, discussed, debated, argued. I suggest that the relevance of these debates and contributions be measured by whether or not they add to the likelihood of hazard control, by whether they provide an additional margin of safety, or subtract from it.

Mount Sinai Investigations

During the past four months my colleagues and I at the Mount Sinai School of Medicine of the City University of New York have initiated a broad program of vinyl chloride-polyvinyl chloride research. These have ranged from studies of vinyl chloride transport in the blood (Professor Gerald Oster) and investigations of genetic damage under Professor Kurt Hirshhorn with Alan Ducatman, to evaluation of histopathology by Professor Hans Popper of our Department of Pathology. Clinical, physiological and epidemiological studies have had the valuable, broad support of the National Institute of Environmental Health Sciences and the statistical and epidemiological approaches have been strengthened by the support of the Environmental Cancer Research Project of the American Cancer Society.

Our clinical field studies have included examination of over 1,700 vinyl chloride-polyvinyl chloride polymerization workers, including 354 current and former workers at the Goodyear Niagara Falls plant, 434 employees at the Dow, Midland, Michigan facility and 401 workers at the South Charleston, West Virginia chemical plant. Some two dozen workers of the Tenneco operation in New Jersey were also examined. Approximately three-quarters were currently employed and one-quarter had either retired or sought other employment.*

Extensive studies were undertaken including full occupational and medical histories, specific analysis of symptoms thought to be associated with

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*We acknowledge with gratitude the valuable assistance given us in these surveys. The Oil, Chemical and Atomic Workers Union, Local S-277 was extremely helpful and the Goodyear Company greatly facilitated our research by making available its records and providing the necessary x-ray facilities that were needed; in Midland, Michigan Local 12073 of the United Steelworkers of America helped us notify the workers concerned and arranged for appropriate examination facilities in the Midland Community Center. Unfortunately, a strike was in progress at the time of the survey; despite this, Dow Scientists, including Dr. B. Balder and Dr. V.K. Rowe, facilitated our inspection of the vinyl operation at the plant. In South Charleston, the Union Carbide Company placed all of its medical facilities at our disposal; this cooperation, together with that of Local 589 of the International Association of Machinists, greatly assisted our work.

vinyl chloride exposure (liver, gastrointestinal, pulmonary, skin, bone, endocrine, etc.) symptoms of peripheral vascular changes including Raynaud's syndrome, status of immediate family, including previous stillbirths and miscarriages, detailed smoking histories and history of alcohol intake, physical examination including heart, lungs, oropharanyx, hands and feet, abdomen, blood pressure, skin. Enlargement of liver and/or spleen was sought and an Allen test was done in each instance. Pulmonary function studies included a broad battery of ventilatory studies and x-rays were made of the chest, hands and feet. Subcutaneous fat aspiration biopsies were made of a large number of selected workers in Midland and South Charleston, while chromosome break studies have been undertaken of selected individuals in the Tenneco, Niagara Falls and South Charleston groups.

In all cases, an extensive battery of blood tests have been undertaken, including the usual standard about of biochemical analyses (blood-urea, nitrogen, sugar, creatinine, uric acid, cholesterol, phosphorus, calcium, bilirubin, serum protein, serum albumin, as well as alkaline phosphatase, SGOT, LDH and SGPT. CBC's were done, including platelet counts in each instance. Urine examination included microscopic study of the sediment. Additional tests included those for fibrogen split proteins, serum protein electrophoresis, alphafetoprotein, Australia antigen, antimitochondrial antigens, antismooth muscles antibodies, antiliver antibodies. Estimations of carcinoma embryonic antigen levels were made in each case; for this, we gratefully acknowledge the assistance of the Hoffman-LaRoche Laboratories.

We are still in the midst of analyzing the results of our surveys in Michigan and West Virginia. Findings are available, however, of our studies in Niagara Falls, and were recently presented at the International meeting on Vinyl-Chloride-Polyvinyl Chloride convened by the New York Academy of Sciences May 10-11, 1974. Copies of these presentations, made by my colleagues Dr. Lilis and Dr. Nicholson, are being submitted for the record, so that details might be readily available.

The plant is an important one, and has over the years produced a significant proportion of U.S. PVC output. The initial facility consisted of six vinyl chloride monomer reaction vessels, a polymerization complex

of four reactors ~~reactors~~ and a building for drying and bagging operations. From 1946, when the plant opened, through 1950, seven men and one supervisor per shift handled the operation for all three areas. Thus, the production force was approximately 30 men. In 1951, a significant expansion took place with 16 additional polymerization reaction vessels and 12 monomer reactors installed, leading to an expanded workforce of approximately 150 hourly employees in the VC-PVC operations. In 1960, the production of vinyl chloride monomers ceased, being received from that point on, in tank cars from Texas. Little change occurred in the total workforce, however.

On March 9-11, we undertook a survey of the workers in this plant, including 267 currently employed (virtually the entire current production workforce) as well as 87 former workers. In both groups, exposure for some had started in 1946, when the plant opened. 197 of the 354 men had worked for 10 years or less and more than half were under 40 years of age. Only 52 had worked for 20 years or more and only 70 of the men were over 50. This immediately points a problem of current vinyl chloride-polyvinyl chloride investigations; the industry is a relatively young one, and the late effects of toxic exposures have only begun to appear; most of our experience is still ahead of us.

While detailed findings will be available in the document submitted for the record, it may be useful to summarize our findings in these 354 workers.

1. Peripheral vascular disease. In 1957 and 1958, Filatova and colleagues first pointed out what they called "toxic angioneuropathy" in VC workers, with another report in 1965 detailing a Raynaud's-like syndrome. Numbness and tingling of the fingers, along with increased sensitivity to cold, were early symptoms. These were often associated with pain and cyanotic discoloration, sometimes involving the toes as well. We have confirmed the importance of these findings. Among the Niagara Falls workers, 85 or 24%, had numbness or tingling, with excessive sensitivity to cold being found in 63 (18%). However, typical Raynaud's syndrome was only present in 20 or 5.7%. As with so

many other vinyl chloride toxicity findings, the prevalence of Raynaud's syndrome was significantly higher among workers with more than 10 years of exposure. Similarly, an abnormal Allen test, indicating delayed arterial circulation in the areas supplied by the ulnar and/or radial arteries, was found in 94 or 26.6% of the examined workers. Here, too, the presence of an abnormal Allen test was significantly higher among workers with more than 5 years of exposure than those who had worked less.

2. Acroosteolysis. We are unable at this time to provide clear information concerning the incidence of typical acroosteolysis in this group, since many of the x-rays of the hands and feet have but recently reached us. We might note, however, that pseudo-clubbing of the fingers was prevalant in 8.7%; in the group with more than 20 years of exposure, it was 17.3%. While pseudo clubbing was almost always associated with signs and/or symptoms of abnormal peripheral circulation, in some cases there was a history of Raynaud's Syndrome which had gradually faded following cessation of exposure, while the pseudo-clubbing had persisted or even progressed.

3. Skin changes were found in 23 of the examined workers, in 9 of whom Raynaud's Syndromewas also present. Perhaps reflecting access to different clinical populations, it should be noted that we found characteristic skin changes of edema, thickness, stiffness, decreased elasticity much less frequently than did the Bonn group, where such changes were very commonly seen. Too, we did not observe the well circumscribed plaque or band areas of scleroderma-like skin changes, so well described by the German group.

4. Hypertension. This has been reported as being a finding of increased frequency among VC-PVC workers. This was not so in our study population. Abnormal urinary findings were also not prominent. In particular, I would mention that gross hematuria was absent and microscopic hematuria was infrequent, a happy finding in view of the description of nephroblastoma among exposed animals in Dr. Maltoni's studies.

5. Liver disease - The liver was found to be slightly or moderately enlarged in 15% of cases, being more frequently so in workers with longer duration of exposure. We found the spleen to be palpable in 12 or 3.4% of cases (considerably less frequent than was the case in the German studies, in which the liver was enlarged in 31 of 50 cases and palpable splenomegaly found in 16). Again, we noted that the prevalance of an enlarged liver was considerably greater in workers with more than 5 years of exposure, compared with those with shorter exposure.

We have analyzed our biochemical results with special reference to liver function tests. The percentages of such abnormalities was not striking in most tests; the bilirubin was greater than 1.1 in 6%, SGOT elevated in 6%, SGPT in 9% and LDH in 2.3%. Alkaline phosphatase, however, was found to be elevated in an important number of workers, 16.6% overall. This ranged from 12.6% elevated among those with 2 years or less of exposure to 25% with elevated levels in the 20 year and over group. When hepatomegaly and or splenomegaly was present, 41% also showed increased alkaline phosphatase levels.

We sought to determine whether alcohol intake might have an important relation to these unusual findings; and we found that 1/3 of the cases with clinical evidence of liver or spleen enlargement, this could have been a factor and, further, in about 25% of those with increased alkaline phosphatase levels, there was a history of significant intake. Nevertheless, analysis showed that elevated alkaline phosphatase did not correlate well with alcohol intake, but did show a significant correlation with duration of vinyl chloride exposure. We suggest that a multiple factor interaction should be considered.

6. Gastrointestinal symptoms and findings - A number of investigators have commented upon the frequency of upper GI symptoms. This was the case with the Niagara Falls vinyl chloride workers as well. However, it is difficult to know whether such symptoms were more common or less common than might be expected in a similar group without VC exposure, in the absence of appropriate control data.

7. Pulmonary disease - In 1970, Szende and colleagues reported pneumoconiosis in a worker exposed to PVC dust. Our examination included careful clinical examination of the chest as well as detailed ventilatory pulmonary function studies and chest x-rays. Abnormalities were found, but at this time the

nature of the defect and its importance are still unclear. In review of the first 142 chest x-rays, 27% were found to show some abnormality; in general, these were nonspecific linear, reticular and nodular infiltrates in the lower lung fields of minimal extent and limited intensity. Symptoms were scant. The frequency of such findings range from 5.2% among those working 2 years or less to one-third with 20 or more years of exposure. Spirometry and maximum expiratory flow volume curves showed that the prevalence of airway obstruction was high - 58% of all workers. Airway obstruction correlated with age and duration of exposure, but showed an association with cigarette smoking only among younger workers, with exposures of 10 years or less. Among older individuals, or with exposures more than 20 years, prevelance was similar in smokers and in nonsmokers, suggesting that the occupational environment was the cause. These findings are being reported by my colleagues, Dr. A. S. Teirstein and Dr. A. Miller. At the moment, we are not sure what to make of these findings. In particular, we do not know whether they are the result of exposure to vinyl chloride monomer gas, or to particulate polyvinyl chloride resin, since admixture of such exposures was common. In the Szende case, particles of PVC were found in the granulomatous lesions on lung biopsy.

In summary: clinical examinations of 354 workers exposed to vinyl chloride in a polymerization plant demonstrated a significant prevalence of liver abnormalities, peripheral vascular changes, and lung abnormalities. The latter may reflect exposure to polyvinyl chloride dust, rather than to the monomer gas. Skin changes were not prominent in this group, although they have been well reported elsewhere, and we were not able to confirm an important element of hypertension. Acroosteolysis was found, probably at levels that have been previously reported in this country. In only a very few cases was it disabling, however.

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Simultaneously with our clinical survey, we initiated an investigation into the mortality experience of workers at this plant. This study, with Dr. William J. Nicholson and Dr. E. Cuyler Hammond, was designed to see whether or not neoplasms were an important cause of death among the polmerization workers, ~~in this plant~~. In particular, we sought to obtain information on the question of whether hemangiosarcoma of the liver was an important hazard with vinyl chloride exposure, or not. It was clear from data elsewhere that hemangiosarcoma occurred -- but how often did it occur?

Using company and union records, we found that 257 men had begun employment at the plant sometime between 1946, when the plant opened, and 1963, and had worked for a minimum of 5 years. We selected the 1963 cutoff date, to allow us to have at least a 10 year period of observation.

We have traced 255 of the 257 men.*

151 of the 255 men had been PVC production workers, 60 were maintenance men and 44 had worked either in shipping or in the laboratory. It was a young cohort. Our analysis was concerned with a period of risk beginning 10 years from first employment; at such a point, 227 of 255 were under the age of 50. Reflecting this, 210 were still working at the time of our survey, 149 at the PVC factory. 21 were alive and retired and we have still 2 to trace. Of those known to be alive, 170 were clinically examined in our survey.

24 of the 255 men were found to have died. 3 died of hemangiosarcoma of the liver and, in each, the pathological specimens obtained at autopsy have been examined by Professor H. Popper and Dr. Lewis B. Thomas and the diagnosis established. In addition, one man died of hepatic fibrosis with bleeding esophageal varices and there were 6 other deaths of cancer, including 2 deaths of lymphoma and 1 of a neoplasm of the brain (glioblastoma).

We have calculated expected and observed deaths among these 255 workers, taking age, year and sex into account. Our calculations cover 2,410

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* In accomplishing this tracing of over 99% of the cohort in less than 2 months, we owe an enormous debt to the members of the Oil Chemical and Atomic Workers Union, Local 8-277, as all individuals were traced directly through personal information obtained from union members. Contact was made with individuals in Florida, California, Louisiana, Colorado and many other states, and Canada; all told, 21 of the 82 individuals who were working elsewhere or retired, were traced and found alive in states other than New York.

person years at risk. The results are preliminary, being based, obviously, on limited experiences and small numbers. Altogether, 19 deaths were expected and 24 were observed. More pertinent, 3.9 deaths of cancer of all sites were expected, and 9 were observed. We would caution against any great reliance on these figures, being based, as they are, on so few deaths, despite the fact that they do represent the total experience of a cohort that was traced almost in its entirety.

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Analysis of the work experience of the 3 men who died of hemangiosarcoma may be of interest. Age at death was 41, 54 and 60, in 1961, 1968 and 1970. All had begun work in 1951 or earlier and 14, 17 and 23 years had elapsed from onset of their vinyl chloride exposure. These figures resemble those for other confirmed cases of angiosarcoma of the liver among polyvinyl chloride workers in the United States, West Germany, Great Britain, Norway and Sweden, where the elapsed periods from first exposure to polyvinyl chloride to diagnosis of hemangiosarcoma of the liver were 11, 12, 14 (2) 15(2), 17, 19, 20(2), 22(2), 23, 24, 26, 27, 28, 29, 30 years.

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In summary: this early followup of individuals exposed for at least 5 years to vinyl chloride in the polymerization facility showed that 3 of 24 deaths were due to angiosarcoma of the liver and another was due to bleeding esophageal varices, known to be not uncommon among such workers. These data demonstrate that this neoplasm, otherwise so rare in the general population (? 1 in 50,000 adult male deaths) is an important hazard of vinyl chloride polymerization workers. Single deaths of glioblastoma, reticulum cell sarcoma and lymphosarcoma are noted. While, obviously, no weight can be given to such isolated observations, their presence is consistent with the increase in cancer of the brain and lymphatic system that has already been observed in the ongoing epidemiological investigation of Tabershaw and Gaffey.

It may be of interest to compare the hemangiosarcoma risk in vinyl chloride polymerization workers with the risk of mesothelioma in asbestos workers. It would appear that, using our observations among four asbestos-exposed work populations previously reported, the hemangiosarcoma risk will exceed that of asbestos mesothelioma. Comparing identical periods of time from first exposure, in 1,175 person years at risk 10-14 years from onset, there was one case of hemangiosarcoma of the liver. There was another in 790 person-years in the 15-19.9 year group. In 375 person-years at risk from 20-21.9 years from onset of exposure, there was one death of hemangiosarcoma of the

liver. On the other hand, in 22,525 person-years at risk, among asbestos workers 10-14 years from onset, there was no case of mesothelioma and in 24,501 person-years 15-19.9 years from onset there were only 5 cases. In 19,789 person-years at risk from 20-24.9 years from onset of exposure, there were 9 cases of mesothelioma.

Comparison of incidence of hemangiosarcoma (VC exposure) and mesothelioma (asbestos exposure).

	VC			Asbestos		
Years from onset	10.14.9	15-19.9	20.24.9	10.14.9	15.19.9	20.24.9
Person years at risk	1175	790	375	22,525	24,501	19,798
Hemangio-sarcoma or Mesothelioma	1	1	1	0	5	9
Cases/1,000 person-years at risk	0.9	1.3	2.7	0	0.2	0.45

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With these data as a background, we have been able to arrive at a number of ~~conclusions~~ which we believe will serve to sharply decrease the risk of both nonmalignant and malignant toxic effects of vinyl chloride exposure. I will limit our observations to those which are particularly pertinent to the proposed standard for vinyl chloride, ~~a public hearing~~

1. Level of exposure: The proposed standard for employee exposure is set at no detectable level, as determined by a sampling and an analytical method capable of detecting vinyl chloride at concentrations at one part per million, plus or minus 50%. I strongly support this proposal. I realize that this particular item of the proposed standard is likely to attract the greatest opposition, particularly from industry. Nevertheless, the issue should be met head on since it lies at the heart of the possibilities of success for the control of vinyl chloride cancer hazard.

What do we actually know? First, based upon their experimental studies, Dow scientists, 15 years ago, proposed a time weighted average of 50ppm for the prevention of nonmalignant toxic effects.

V.K. Rowe reported to the New York Academy of Sciences meeting:: "In 1959, when the results of our toxicological studies on animals caused us to be more concerned for both vinyl and vinylidene chloride exposure, continuous monitors were installed in our polymer plants and a rather dramatic reduction in workroom air concentration was achieved. This was brought about by setting a goal that a time-weighted average exposure for an 8 hour, 5 day week, should not exceed 50ppm for vinyl chloride and 25ppm for vinylidene chloride," and "...in the ensuing years between 1960 and 1967 we were generally successful in reaching these goals." Dr. Rowe further noted that, after Dr. Viola's report of tumors in rats in 1970-1971, a closer look was taken of Dow operations. "In our oldest monomer plant we found time weighted averages to be generally less than 2ppm but there was one job that showed 45ppm and another job that showed 14ppm. Personnel monitoring during 1973 revealed that all time-weighted average values were below 10ppm," except for some laboratory employees. "In our second oldest monomer plant, which began operation in 1958....the highest time-weighted average exposure of 10-15ppm again was associated with laboratory workers; all others were less than 5ppm." "In the newest monomer plant which began operation in 1969, time-weighted average values range from less than 1 to 10.4ppm. In the only polymer plant now operating, time-weighted average values have been markedly decreased, the levels during 1973 generally were well below 25ppm, most of them being in the 1-5ppm range."

How can we translate Dow's recommendation of 50ppm for nonmalignant disease to the prevention of malignant effects? The most authoritative generalization in this regard has been made by Dr. Herbert Stokinger, Chairman of the Threshhold Limit Value Committee of the American Conference of Governmental Industrial Hygienists, who has recommended that levels for the prevention of neoplasms should be approximately one five-hundreth of toxic, nonmalignant levels. If we were to take Dr. Stokinger's advice, an acceptable TLV for vinyl chloride would be 0.1ppm.

As it turns out, Dr. Stokinger may well have made a shrewd estimate. We now know, from the studies of Dr. Maltoni and the Biotest Laboratories results, that experimental cancer in rats and mice will occur at 50ppm.

In terms of human experience, we have only two benchmarks. First, the only safe level that is known, to avoid vinyl chloride-associated hemangiosarcoma, is zero. At the other end of the spectrum we know that hemangiosarcomas have occurred at levels which obtained in the past in polymerization plants. Unfortunately, we have little information concerning the details of such levels. Although there was a published TLV for vinyl chloride, 500ppm, recommended by the ACGIH, apparently little monitoring or surveillance was done and few companies have any significant number of measurements made, until recent months. There are no data whatsoever concerning populations of workers exposed at 5ppm, 10ppm, 15ppm that might correlate with observations concerning long-term risk, 15, 20, 25, 30 or more years from onset of exposure.

Animal data, of course, is of assistance. Dr. Maltoni has a paper in press which will be published in approximately a month, giving his results at 131 weeks of rats exposed for 52 weeks at varying concentrations (10,000, 6,000, 2,500, 500, 250, 50). The number of angiosarcomas of the liver (in addition to other tumors) were 6, 11, 9, 7, 2, 0. He has since observed two angiosarcomas at 50ppm. At the New York Academy of Sciences meeting, a report from the Biotest Laboratories of preliminary results in an NCA supported study, also noted that angiosarcomas occurred, in mice, at 50ppm.

In view of these considerations, I suggest that the only prudent course for the prevention of hemangiosarcoma of the liver among vinyl chloride workers is to provide a work environment with no detectable level of vinyl chloride. Of course, accidents will occur and higher levels of VC will result; in such circumstances, as the proposed standard states, appropriate personal protection should be provided.

There are a number of theoretical considerations which reinforce the recommendation. Dr. Maltoni has demonstrated important species differences in neoplastic response to vinyl chloride. Thus, mice show not

only angiosarcoma of the liver, but also pulmonary neoplasms and mammary tumors, but have not, at this writing, yielded kidney tumors. We have no way of judging at this time what the vinyl chloride induced neoplastic spectrum will be in man. It may turn out that tumors other than hemangiosarcoma will be, on the overall, much more important that the latter. Thus, Dr. Tabershaw's suggestion that pulmonary neoplasms seem to be increased, may be a key observation, since even a modest rise in incidence of this common tumor among men will result in an important number of excess neoplastic deaths among vinyl chloride exposed workers.

2. Technical difficulties for industry: I am confident that the claim will be made that the attainment of a no-detectable level standard will occasion a great deal of expense and marked hardship for industry. I don't doubt this. Nevertheless, I believe that the standard is feasible and attainable. For example, I have quoted the levels already achieved at Dow Chemical, as reported by Dr. Rowe, at the New York Academy of Sciences meeting.

At the same meeting, Byrén and Holmberg of Sweden reported that, before any new efforts to sharply control the situation were instituted, "air concentrations in the polymerization plant are today 18-20ppm VC on the average in the reactors rooms and under 5ppm in the drying and packaging department." I would call attention to the fact that we have only begun to look at the question of control of VC exposures and a world of achievement lies before us.

Indeed, it has been stated that it would be unwarranted to have our industrial hygiene engineers attempt to do other than achieve complete control. Professor Morton Corn of the University of Pittsburgh Graduate School of Public Health addressed himself to this question at the New York meeting. "I am often asked to design ventilation controls to meet a certain Threshold Limit Value and indicate that, contrary to popular understanding of the design approach to general or local exhaust ventilation, it is not possible to design, or to assure achievement of, a TLV." He stressed that "...unless there is a realistic estimate of the emission of a pollutant in the work environment, one cannot estimate the average airborne concentration. In most cases in my experience, a generation rate estimate was subject to ± 500% or more variation. Thus, contrary to popular conception, we cannot design to a desired concentration." (Emphasis in original.) "In summary, ventilation approaches to the control of

this compound are standard, and while they are not subject to precise prediction of results, sufficient design options exist to ensure control for materials deemed highly toxic. In the past, the problem has been that of characterizing this compound as a low toxicity one, and adopting control measures consistent with this designation. Future design will be for a highly toxic material with techniques appropriate to this designation."

3. Decrease of neoplastic hazard with control of exposure: We have good reason to believe that, with control of VC exposure, there will be a sharp decline in neoplastic risk. While it may never be zero, we could hope to approach this point. Evidence exists in Dr. Maltoni's experiments that, at least for levels likely to occur in the workplace, the occurrence of tumors with VC exposure is not an all-or-none affair. I have already quoted the declining number of tumors with declining exposure concentrations, in rats exposed for 52 weeks. Additional experiments provide equally optimistic perspectives, in terms of workers who have already been exposed. These data suggest that, as we now control vinyl chloride exposure, the risk of development of hemangiosarcoma among workers who began their employment in 1950's, 1960's and 1970's, will diminish. Thus, Dr. Maltoni exposed two groups of rats and observed the incidence of hemangiosarcoma at 60 weeks from onset of exposure. However, one group was exposed for 17 weeks and then observed while the other group was exposed for 52 weeks and observed. There was a sharp difference in the incidence of angiosarcoma in the two groups, at each level of exposure. Thus, the 52 week group showed neoplasms at 10,000, 6,000, 2,500, 500 and 250ppm. The 17 week group, observed for the same length of time, showed no such neoplasms. It may be that, as further time goes by, the 17 week group will eventually show neoplasms. There are theoretical considerations which would point to this. From a practical point of view, it is certainly important to maintain a neoplasm-free life for as long as possible for vinyl chloride workers already exposed in the past. Dr. Maltoni's experiments point to how this can be done -- cessation of further exposure.

4. Nonmalignant disease at lower levels of exposure. Although we have no data at this time which allow us to correlate potential neoplastic risk with prevalence of toxic, nonmalignant disease, there may be some relation. In any case, data on this aspect of the question are surely relevant to the evaluation of a proposed standard, even for nonmalignant disease. You will remember that I stated that our laboratory undertook a survey of current and former VC-PVC employees at the Dow Chemical Company in Midland, Michigan. I have further detailed to you the valuable information provided by Dow scientists concerning levels of exposure which have obtained in their facility, in the past.

The results of our survey are still being ~~analyzed~~ studied but I have analyzed data with regard to what seem to be in our hands one of the most sensitive, practical parameters of VC toxicity -- elevation of alkaline phosphatase. 10% of 434 workers tested had serum elevations of this enzyme; almost 6% being at levels beyond 2 standard deviations from the ~~mean~~ normal range. Our first examination of our survey results also indicates that the percentage of individuals with palpable enlargement of liver and/or spleen was very much the same as that observed in the Niagara Falls group.

5. Polyvinyl chloride resin: At the New York Academy of Sciences meeting, Lange and his colleagues and Marsteller and his, reported cases of classical vinyl chloride disease among workers exposed only to the polymer resin, in secondary PVC production processes. This points to the urgent need for the application of the proposed standard to operations in which the polymer is used. Further, I would urge that industry make every effort to remove residual VC monomer from the polymer resin. Dr. Volkheimer reported at the New York meeting that PVC particles, on ingestion, rapidly enter the bloodstream and lymphatics, and the persorbed particles then appear in the urine, pulmonary alveoli, peritoneal cavity, cerebral spinal fluid and in the milk of animals and lactating women. He also demonstrated the transplacental passage of PVC particles. Since it is often very difficult to prevent the dissemination of fine PVC particles into the environment of a plant, it would be prudent to ensure that if such particles are ingested, they not be contaminated with vinyl chloride

monomer. For the same reason, I would urge that the proposed standard is surely correct in requiring that "food, beverages and like products ...be prohibited in the regulated area."

6. Medical surveillance: In general, I believe the section devoted to this problem is a useful one. However, there are a number of weaknesses which I suggest should be corrected. The most important concerns post-employment surveillance, for which no provision is made. Dr. Paul D. Bork of the National Institute of Arthritis, Metabolism and Digestive Diseases (Chief, Section on Diseases of the Liver) reported results of his studies of a worker at the B.F. Goodrich facility in Louisville, who had worked for $5\frac{1}{2}$ years, was found to have liver disease on biopsy and biochemical tests, and then was removed from further exposure for $2\frac{1}{2}$ years before his admission to the Clinical Center of the National Institutes of Health. It was now found that the blood tests were normal. However, a liver biopsy was again done -- and extensive fibrosis was noted. This "...appeared to be at least as extensive, if not more extensive, as in the earlier specimen." Dr. Bork stated that "The normal values observed in the patient for so many tests of liver function in the presence of a significant histological lesion indicate that there will be a serious problem designing an adequate regimen for screening vinyl chloride workers. Furthermore, the follow-up of patients with proved vinyl chloride liver injury after their removal from exposure cannot be based on any currently available routine test." Thus, negative results on separation from employment is no guarantee at all that liver injury has not occurred, requiring medical surveillance. He concluded "Detailed evaluation of a single patient $2\frac{1}{2}$ years after his last exposure to vinyl chloride indicates clearly that vinyl chloride associated hepatic fibrosis persists, and may actually have progressed, despite removal from further exposure. Furthermore, because of the nature of the hepatic injury, the lesion may be quite extensive and may result in portal hypertension in the absence of any abnormalities of standard liver function tests." Our own studies gave clear evidence of disease among workers who had left vinyl chloride employment. Thus, an abnormal Allan test was found in 25.5% of those currently exposed, and 29.9% among those with prior exposure. Raynaud's Syndrome was found in

6.4 of those actively working with the material and 3.4% of those whose exposure had ceased. Abnormal liver function tests were in the same direction, 16% in those currently employed and 18% in those with prior employment.* Some mechanism must be found to provide post-employment medical surveillance for workers known to have been exposed to vinyl chloride. Some additions might be made to the surveillance procedures themselves. Thus, there are some hints that leukemia and lymphoma may may be found to be increased. (In one case, in our survey, findings consistent with lymphatic leukemia have been made; these are now being checked.) Since it is recommended that blood platelets be studied, white blood cell counts, with differential analysis, should be simultaneously undertaken.

It would appear useful that a complete blood count be done at the same time, a procedure which would present no great difficulty. This would cover the possibility of unappreciated gastrointestinal tract bleeding with resulting anemia, as well.

In view of our finding of abnormal chest x-rays and abnormal pulmonary function tests in a significant proportion of the workers in at least one plant, a routine PA chest film would seem to be in order, as would ventilatory pulmonary function studies. This addition would also cover the possibility, suggested in the data of Dr. Tabershaw and Dr. Gaffey, that pulmonary neoplasms are increased in incidence, in vinyl chloride workers.

Finally, the proposed standard states that "If liver function abnormalities are determined to be unrelated to liver disease, the employee

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*Similar findings were reported by Dr. Veltman and his colleagues at the New York meeting, insofar as thrombocytopenia was concerned. Among 29 patients with low platelets, who had left work, 6 improved, 3 showed no change -- and 20 deteriorated!

may be permitted to return to vinyl chloride-related employment, subject to individual medical evaluation." I wonder about the wisdom of this.

7. Exposure of women: The demonstration by Dr. Maltoni that exposure of pregnant rats to vinyl chloride from day 12 to day 18 of pregnancy may result in angiosarcoma in the offspring, indicates that women in the childbearing age should not work in any area in which there are detectable levels of vinyl chloride. This should be made a hard and fast rule.

STATEMENT OF DR. IRVING J. SELIKOFF AND DR. WILLIAM J. NICHOLSON, MOUNT SINAI SCHOOL OF MEDICINE

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DR. SELIKOFF: Thank you, Judge Myatt. My name is Dr. Selikoff. I am Professor of Medicine and Director of the Environmental Sciences Laboratory at the Mount Sinai School of Medicine, City University of New York. I am also, to indicate the range of my interests, editor in chief of the Journal of Environmental Research; I am president of the Society for Occupational and Environmental Health; and a past president of the New York Academy of Sciences.

A little over four months ago your Department and other Agencies set an emergency standard for vinyl chloride. I suppose this is a tribute to scientists in our country and elsewhere, to the responsible government Agencies, especially the National Institute of Occupational Safety and Health, to the many leaders of labor unions representing workers at risk of vinyl-chloride associated disease and to the equally concerned leaders of the plastics industry, that an extraordinary amount of information has been collected and analyzed in the weeks that have passed, information which now allows us to better judge the difficulties that we face and to consider the steps that must be taken for their correction.

I would say particular tribute--and perhaps after

available to all of you, as you wish.

Now, the Niagara Falls plant is an important one and has over the years produced a significant portion of U.S. PVC output. The initial facility employed in 1946 approximately 30 men. In 1951 a significant expansion took place to approximately 150 hourly employees in the VC-PVC operation. On March 9 and 11, we undertook a survey of the workers in this plant, including the 267 currently employed (virtually the entire current production work force) as well as 87 former workers. They came from as far away as Pennsylvania, Rochester and so forth, to be examined.

In both groups, exposure for some had started in 1946 when the plant opened. 197 of the 354 men had worked for ten years or less, and more than half were under 40 years of age. Only 52 had worked for 20 years or more and only 70 of the men were over 50. More than half had begun work after 1960. I detail this, because it immediately points a problem of current vinyl chloride-polyvinyl chloride investigations--the big problem that we have. And one of the reasons why when you ask us questions that I have heard all day, some times we don't have the answers. and that is that the industry is a relatively young one, and the late effects of toxic exposures have only begun to appear. Most of our experience, whatever it is going to be, is still ahead of us.

While detailed findings are available in the

documents I have mentioned, I would like to summarize some of our findings in these 354 workers.

First with regard to peripheral vascular disease. In 1957 and 1958, Filatova and colleagues first pointed out what they called a "toxic angioneuropathy" in vinyl chloride workers, with another report in 1965 detailing a Raynaud's-like syndrome. Numbness and tingling of the fingers, along with increased sensitivity to cold, were early symptoms. We have confirmed the importance of these findings. Among the Niagara Falls workers, 85 or 24 percent, had numbness or tingling, with excessive sensitivity to cold being found in 63, or 18 percent. However, the typical Raynaud's syndrome was only present in 20, or 5.7 percent. As with so many other vinyl chloride toxicity findings, the prevalence of Raynaud's syndrome was significantly higher among workers with more than 10 years of exposure. Similarly, an abnormal Allen test, indicating delayed arterial circulation in the areas supplied by the ulnar and/or the radial arteries, was found in 94, or 26.6 percent, of the examined workers.

Acroosteolysis. Generally, in scientific meetings, you hardly hear anything other than acroosteolysis, and I have hardly heard it all day today, which is probably just as well. Now, we are unable at this time to provide clear information concerning the incidence of typical acroosteolysis in this group, since many of the X-rays of the hands

and feet have but recently reached us. And they are being read for us by our experts in our X-ray department, and this takes time. We might note, however, that pseudo-clubbing of the fingers was prevalent in 8.7 percent clinically; in the group with more than 20 years of exposure, it was 17.3 percent.

Now, skin changes were found in 23 of the examined workers. Perhaps reflecting access--you will notice how cautious I am now--perhaps reflecting access to different clinical populations, it should be noted that we found characteristic skin changes of edema, thickness, stiffness, decreased elasticity, much less frequently than did the University of Bonn group, where such changes were very commonly seen. Too, we did not observe the well circumscribed plaque or band areas of scleroderma-like skin changes, so well described by the German group. I don't know the explanation for this. We just didn't see as much in the skin as the German scientists reported.

Fourth, hypertension. This has also been reported, primarily by Romanian scientists, as being a finding of increased frequency among VC-PVC workers. It was not so in our study population. We didn't find any excess of hypertension among the people studied by us. Abnormal urinary foundings were also not prominent. In particular, I would mention that gross hematuria was absent and microscopic

hematuria was infrequent. I consider this a happy finding in view of the description of kidney tumors among exposed animals in Dr. Maltoni's studies.

Liver disease. The liver was found to be slightly enlarged or moderately enlarged in 15 percent of all the workers in this plant, being more frequently so in workers with longer duration of exposure. We found the spleen to be palpable in 12, or 3.4 percent, of cases. Now, this is considerably less frequent than was the case in the German studies, in which the liver was enlarged in 31 of 50 cases and there was palpable splenomegaly, enlarged spleen, in 16 out of the 50. Now, why the Germans have found the spleen to be enlarged more frequently than we have, I cannot tell you. We noted that the prevalence of an enlarged liver was considerably greater in workers with more than five years of exposure compared with those with shorter exposure. Incidentally, I think that even 15 percent of a population to have an enlarged liver is enough, but we didn't find as much as the Germans.

We have analyzed our biochemical results with special reference to liver function tests. Now, the percentage of such abnormalities was not striking in most of the tests; the bilirubin was greater than 1.1 milligrams in 6 percent, SGOT elevated in 5 percent, SGPT in 5 percent and LDH in 2.3 percent. Alkaline phosphatase, however, was found to be

elevated in an important number of workers, 16.6 percent overall. This ranged from 12.6 percent elevated among those with two years or less of exposure to 25 percent with elevated levels in the 20-year and over group. When an enlarged liver or an enlarged spleen was present, 41 percent showed increased alkaline phosphatase levels.

We sought to determine whether alcohol intake might have an important relation to these unusual findings; and we found that 1/3 of the cases with clinical evidence of liver or spleen enlargement, there could have been a factor of alcohol and, further, in about 1/4 of those with increased alkaline phosphatase levels, there was a history of significant intake. There may indeed be a multiple factor interaction that should be considered.

Six, pulmonary disease. In 1970, Szende and colleagues reported pneumoconiosis in a worker exposed to PVC dust. Our examination included careful clinical examination of the chest as well as detailed pulmonary ventilatory function studies and chest X-rays. Abnormalities were found, but at this time the nature of the defect and its importance are still unclear.

In a review of the first 142 chest X-rays, 27 percent were found to show some abnormality. In general, these were nonspecific linear, reticular and nodular infiltrates in the lower lung fields of minimal extent and

limited intensity. Symptoms were scant. The frequency of such findings range from 5.2 percent among those working for two years or less to one-third with 20 or more years of exposure. Spirometry and maximum expiratory flow volume curves showed that the prevalence of airway obstruction was high--% percent of all workers. The function test shows even more than the X-rays. Airway obstruction correlated with age and duration of exposure, but showed an association with cigarette smoking only among younger workers, with exposures of ten years or less. Among older individuals, or with exposures more than 10 years, prevalence of abnormal findings was similar in smokers and in nonsmokers, suggesting that the occupational component was the cause. Nonsmokers also had the same incidence of abnormal lung findings.

Now, at the moment, we are not sure what to make of these findings. In particular, we do not know whether they are the result of exposure to vinyl chloride gas or to particulate polyvinyl chloride resin. I don't know. Admixtures of such exposures were common. As you walked through the plant, you often saw the light powder in areas in which you had assumed there would be only vinyl chloride exposure.

In the Brooks case, particles of PVC were found in the granulomatous lesions, the scarring lesion, on lung biopsy.

In summary, clinical examinations of 354 workers

exposed to vinyl chloride in a polymerization plant demonstrated a significant prevalence of liver abnormalities, peripheral vascular changes and lung abnormalities. The latter may reflect exposure to polyvinyl chloride dust, rather than to the monomer gas. Skin changes were not prominent in this group, although they have been well reported elsewhere, and we were not able to confirm an important element of hypertension. Acroosteolysis was found, probably at levels that have been previously reported in this country. In only a very few cases was it disabling, however.

Now, simultaneously with this clinical survey, we initiated an investigation into the mortality experience of workers at this plant. This study, with Dr. Nicholson and Dr. E. Cuyler Hammond of the American Cancer Society, was designed to see whether or not neoplasms were an important cause of death among its polymerization workers. It was clear from data elsewhere that hemangiosarcoma occurred, but the question that we wanted answeredwas--how often did it occur?

And I think it might be best at this point to have Dr. Nicholson give you his firsthand information of this investigation.

DR. NICHOLSON: Utilizing union and company records, a cohort of 257 individuals was established, each of whom had been occupationally exposed to vinyl chloride for

at least five years subsequent to 1946 in the polyvinyl chloride polymerization facility, having begun such employment in the period 1946 through 1963.

This included all individuals so employed in that plant during that time. We have determined their mortality status as of the tenth anniversary of their employment through April, 1974. The five-year exposure criterion was established for this preliminary study in order that the effects of significant exposures be established. The criterion that observations would begin only after ten years from onset was selected so that one might focus on the long-term effects of vinyl chloride exposure. While the exposures began in 1946, only a relatively few individuals were employed prior to 1951, when a significant increase in the work force took place. Thus, the majority of the cohort had a bare 20 years or less from onset of exposure.

In fact, if one calculates the person-years of risk in the cohort observation period, 32 percent of those person-years at risk occurred prior to 20 years from onset of exposure, so the difficulty in assessing the long-term effect is present here, having really only a very limited time in which to look for effects that may be manifest 20, 30, perhaps over 40 years from onset of exposure.

Of the 257 individuals exposed since 1946, 255 have been traced and their current health status established.

Of the 255 so traced, work histories and, to a large extent, medical histories, have been documented. 151 of the 255 had been PVC production workers, with work in the reactor area or else work in the bagging of the resin. 60 were maintenance men and 44 had either worked in shipping or in the laboratory. This latter group of 44 would have relatively low exposure compared to those that were--experienced by the reactor production workers. But the group was too small to treat them separately and they do dilute the results of the heavily exposed individuals somewhat.

227 of the 255 were under the age of 50, reflecting this, 210 were still working at the time of our survey, 149 in the PVC facility, 21 were alive and retired and we still had two to trace. Of those known to be alive, 100 were clinically examined in the survey Dr. Selikoff has previously described. 24 of the 255 were found to have died, three of hemangiosarcoma of the liver, and each case the pathological specimens obtained at autopsy have been verified by Dr. Popper and Dr. Thomas of the National Cancer Institute.

In addition, one man died of hepatic fibrosis with bleeding esophageal varices and there are six other deaths of cancer, including two deaths from lymphoma and one neoplasm of the brain, a glioblastoma.

We have calculated the observed and expected deaths

among these 755 workers, taking into account age, years and sex. Our calculations cover 2410 person years at risk. The results are preliminary, being based obviously on the limited experience in small numbers. Altogether, 19 deaths were expected, whereas 24 were observed.

More pertinent, 3.9 deaths of cancer of all sites were expected and 9 were observed. We would caution against any great reliance on those figures, being based as they are on so few deaths. Despite the fact that they do represent the total experience of a cohort that was traced almost in its entirety--that is, more than 99 percent of the individuals in the cohort were found.

The analysis of the work experience of the three men who died of hemangiosarcoma may be of interest. Age of death was 41, 54 and 60 years in 1961, 1968 and 1970. All had begun work in 1951 or earlier and 14, 17 and 19 years had elapsed from onset of their vinyl chloride exposure.

These figures resembled those from other confirmed cases of angiosarcoma of the liver among polyvinyl chloride workers in the United States, West Germany, Great Britain, Norway and Sweden, where elapsed period from first exposure ranged from 11 years to as much as 30 years.

In fact, [illegible] the estimate that the elapsed period from onset of exposure of 20 years is a rough average for

such deaths, comes about in part only because there is a very short period in which we could have observed these deaths. Perhaps as time progresses it will be found that the elapsed period may indeed may be longer and that much of our experience may be still ahead of us.

In summary, these data are derived from early follow-up of individuals exposed for five years to vinyl chloride in a polymerization facility and demonstrate in these group that 17 percent of the deaths that occurred were causally related to exposure to vinyl chloride. Three of the 24 deaths were due to angiosarcoma of the liver and the fourth was due to bleeding esophageal varices, known to be not uncommon among such workers.

These data demonstrate that this neoplasm, the angiosarcoma, otherwise so rare in the general population, is an important hazard of vinyl chloride polymerization workers.

The single death of glioblastoma, reticulum cell sarcoma and lymphosarcoma are noted. But one cannot make a causal relationship on the basis of this study. The finding of lymphomas and brain tumors in other similar studies of polyvinyl chloride production workers suggests that they may also be causally related to the vinyl chloride exposure.

We will need more data on this in the future.

The data also speak clearly for the need to prevent exposure to vinyl chloride and for surveillance and early disease detection of those who have experienced vinyl chloride exposure in the past.

With this I would strongly support the proposed standard of OSHA calling for a non-detectable level of vinyl chloride exposure in terms so defined in that standard, that is, with an instrumentation capable of detecting one part per million.

DR. SELIKOFF: It was of interest to us, since we are studying other causes of occupational cancer, to compare the hemangiosarcoma risk in vinyl chloride polymerization workers with the risk of misothelioma in the asbestos workers. It would appear that, using our observations among the four asbestos-exposed work populations previously reported, that the hemangiosarcoma risk will exceed that of asbestos misothelioma.

We have done comparisons by person-years of risk among--and taking into account period from onset of exposure --among our vinyl chloride workers and among our asbestos workers. There were 1,175 person-years at risk from 10 to 14 years from onset of exposure, and there was one hemangiosarcoma death. There were 790 person-years at risk from 15 to 19 years and there was one death. And there were 375 person-years at risk of 20 to 24 years from onset and, again,

one death. For the asbestos workers, there were 22,525 person-years at risk of 10 to 14 years and there wasn't a single misothelioma. In 24,501 person-years at risk from 15 to 19 years, there were five misotheliomas, and from 20 to 24 years from onset of exposure, in 19,798 person-years of risk, there were nine cases.

This gives, for cases of hemangiosarcoma or misothelioma, per thousand person-years at risk, as follows: 0.9 for vinyl chloride, 0 for asbestos, in 10 to 14 years; it is 1.3 for vinyl chloride, 15 to 19 years, against 0.2 for asbestos; and 2.7 for 20 to 24 years for vinyl chloride against 0.45 for misothelioma due to asbestos exposure.

Now, these numbers are small, but I thought it might be useful to at least give some hint of the way the data are beginning to go.

Now, with these data as a background, we have been able to arrive at a number of recommendations which we believe will serve to sharply decrease the risk of both non-malignant and malignant toxic effects of vinyl chloride exposure.

I will limit our observations to those which are particularly pertinent to the proposed standard for vinyl chloride.

First of all, with regard to the level of exposure. Let's get right and grapple with the important problem first. The proposed standard, as you know, is for no detectable level,

using a technique which will detect vinyl chloride at concentrations at one part per million, plus or minus 50 percent. I realize that this particular item, which I support, is likely to attract the greatest opposition--and if I thought so before coming down here today, it certainly has been confirmed as I sat here.

Nevertheless, the issue should be met head on, since it lies at the heart of the possibilities of success for the control of vinyl chloride cancer hazard.

Now, what do we actually know? First, based upon their experimental studies, a group of excellent scientists at Dow Chemical, 15 years ago, proposed a time-weighted average of 50-ppm for non-malignant toxic effects; based upon their animal toxicity studies, this was what they proposed. 15 years ago, for non-malignant effects.

Dr. Rowe reported to the New York Academy of Sciences meeting on May 11 "In 1959, when the results of our toxicological studies on animals caused us to be more concerned for both vinyl and vinylidene chloride exposure, continuous monitors were installed in our polymer plants and a rather dramatic reduction in workroom air concentration was achieved. This was brought about by setting a goal that a time-weighted average exposure for an 8-hour 5-day week should not exceed 50 parts per million for vinyl chloride and 25 parts per million for vinylidene chloride," and

"...in the ensuing years between 1960 and 1967 we were generally successful in reaching these goals."

Dr. Rowe further noted that, after Dr. Viola's report of tumors in rats in 1970 and 1971, a closer look was taken of Dow operations. "In our oldest monomer plant we found time weighted averages to be generally less than 2 ppm but there was one job that showed 45 ppm and another job that showed 14 ppm. Personnel monitoring during 1973 revealed that all time-weighted average values were below 10 ppm," except for some laboratory employees.

"In our second oldest monomer plant, which began operation in 1958...the highest time-weighted average exposure of 10-15 ppm again was associated with laboratory workers; all others were less than 5 ppm." "In the newest monomer plant which began operation in 1969, time-weighted average values range from less than 1 to 10.4 ppm. In the only polymer plant now operating, time-weighted average values have been markedly decreased, the levels during 1973 generally were well below 25 ppm, most of them being in the 1-5 ppm range."

Now, how can we translate Dow's recommendation of 50 parts per million for non-malignant disease to the prevention of malignant effects? The most authoritative generalization in this regard has been made by Dr. Herbert Stokinger, Chairman of the Threshhold Limit Value Committee

of the American Conference of Governmental Industrial Hygienists, who has recommended that levels for the prevention of neoplasms should be approximately one five-hundredth of toxic, non-malignant levels. If we were to take Dr. Stokinger's advice, an acceptable TLV for vinyl chloride would be 0.1 part per million.

And we heard this morning from Dr. Schneiderman that two other scientists have had estimates which range from one-hundredth of the non-malignant toxic level to one-five thousandth.

So it seems that Dr. Stokinger may have made a shrewd guess and came right in the middle.

Now, in terms of human experience, we have only two benchmarks. First, the only safe level that is known is zero. At the other end of the spectrum, we know that hemangiosarcomas have occurred at levels which obtained in the past in the polymerization process. Unfortunately, we have little information concerning the details of such levels. Although there was a published TLV for vinyl chloride recommended by the ACGIH, apparently little monitoring or surveillance was done and few companies have any significant number of measurements made until recent months. Indeed, if the polyvinyl chloride-vinyl chloride companies had done their work over the last fifteen years when they should have, because there has been a TLV for vinyl chloride,

we would be able to take our 13 cases of hemangiosarcoma in the polymerization plant and with their assistance and their data work out an integrated value of exposure, and we would be able to tell you exactly what the levels were which have caused hemangiosarcoma in the past.

Unfortunately, these data are not available.

Now, we then turn to animal data, and they are of some assistance. Dr. Maltoni has a paper in press giving his results at 131 weeks of rats exposed for 52 weeks at varying concentrations (10,000, 6,000, 2,500, 500, 250 and 50 parts per million). The number of angiosarcomas of the liver, in addition to other tumors, were 6, 11, 9, 7, 2, 0. As you decrease the dosage, down comes the risk of developing angiosarcoma. He has since observed two angiosarcomas at 50 parts per million and, of course, the Biotest Laboratories have in their preliminary results also noted that angiosarcomas have occurred in mice at 50 parts per million.

In view of these considerations, I suggest that the only prudent course for the prevention of hemangiosarcoma of the liver among vinyl chloride workers is to provide a work environment with no detectable level of vinyl chloride. Of course, accidents will occur and higher levels of VC will result; in such circumstances, as the proposed standard states, appropriate personal protection should be provided.

Now, there are a number of theoretical considerations

which reinforce this recommendation. Dr. Maltoni has demonstrated important species differences in neoplastic response to vinyl chloride. Thus, mice--his original studies began with rats, but then he took mice--and the mice showed not only angiosarcoma of the liver but also lung tumors and breast tumors. Now, the mice, however, did not show kidney tumors, which the rats did.

We have no way of judging at this time what the vinyl chloride induced neoplastic spectrum would be in man. I don't know whether we are going to be more like the mice or more like the rats or more like some other animal. It may turn out that tumors other than hemangiosarcoma will be, on the overall, much more important than angiosarcoma. Thus, Dr. Tabershaw's suggestion that pulmonary neoplasms seem to be increased, may turn out to be a key observation, since even a modest rise in incidence of this common tumor among men will result in an important number of excess neoplastic deaths among vinyl chloride exposed workers.

With regard to the technical difficulties for industry, I am--I was sure before coming here that the claim was going to be made that no detectable level will cause a great deal of expense and marked hardship for industry, and I don't doubt this at all. Nevertheless, I believe that the standard is feasible and attainable. I have just quoted the levels already achieved at Dow Chemical and reported by Dr.

Rowe at the New York Academy of Sciences meeting.

Indeed, I would call to your attention--I don't know whether all of us got it--Mr. Bommarito's statement earlier this afternoon, when he referred to the work of Professor Corn at the Graduate School of Public Health in Pittsburgh. Dr. Corn stated, and I would like to quote him exactly--"I am often asked to design ventilation controls to meet a certain Threshold Limit Value and indicate that, contrary to popular understanding of the design approach to general or local exhaust ventilation, it is not possible to design or to assure achievement of a TLV."

If we were to tell Dr. Corn to give us a TLV of ten or 15 or 20, his answer would be that it can't be done. He stressed that "...unless there is a realistic estimate of the emission of a pollutant in the work environment, one cannot estimate the average airborne concentration. In most cases in my experience, a generation rate estimate was subject to plus or minus 500 percent or more variation. Thus," --and I am still quoting Dr. Corn--"Thus, contrary to popular conception, we cannot design to a desired concentration." "In summary, ventilation approaches to the control of this compound are standard, and while they are not subject to precise prediction of results, sufficient design options exist to ensure control for materials deemed highly toxic. In the past, the problem has been that of characterizing this

compound as a low toxicity one, and adopting control measures consistent with this designation. Future design will be for a highly toxic material with techniques appropriate to this designation."

I would like to turn now to something which is closer to my heart. Until now, in a sense, we have been talking of how to protect the next generation of vinyl chloride workers--whether we get it to no detectable level or one part per million or five parts per million, we are going to protect everybody in the future.

I have another approach to this. We have good reason to believe that, with control of vinyl chloride exposure, there will be a sharp decline in neoplastic risk even for the current work force. While it may never be zero, we could hope to approach this point. Evidence exists in Dr. Maltoni's experiments that, at least for levels likely to occur in the work place, the occurrence of tumors with VC exposure is not an all-or-none affair. I have already quoted the declining number of tumors with declining exposure concentrations in rats exposed for 52 weeks. Additional experiments that he has done provide equally useful perspectives in terms of workers who have already been exposed. These data suggest that, as we now control vinyl chloride exposure, the development of hemangiosarcoma among workers who began their employment in the 1940's,

1950's and 1960's and 1970's will diminish. Dr. Maltoni exposed two groups of rats. He exposed one group at the varying levels--10,000, 6,000, 2,500, 500, 250 and 50 parts per million. He exposed them for 52 weeks and then observed the number of hemangiosarcomas at 60 weeks.

He exposed another group of rats for 17 weeks. In other words, he stopped the exposure, but let them live till 60 weeks again, and observed the number of hemangiosarcomas.

Among those exposed for 52 weeks in which the exposure was allowed to continue, there were tumors in each except the 50 parts per million, in each of the other exposure ranges. Among the rats exposed in the same conditions, in the same chambers, but only for 17 weeks, the exposure being stopped at that point, and examined at 60 weeks, there wasn't a single angiosarcoma.

We can therefore hope that as we now stop vinyl chloride exposure for the current work force, that their risk of dying of angiosarcoma will be lessened. From a practical point of view, as you know, it may be that we are not going to prevent angiosarcoma among them as much as we would like, but rather that the tumors will develop after a much longer period of time. Well and good, I will put up with a tumor that may develop at age 95. I would like it not to develop at all, but I would also like the man to live out as much of his life as possible.

So that from this point of view, for the protection of the men who are working for you now, for the protection of the men who have in the past 30 years had vinyl chloride exposure, it is important to stop vinyl chloride exposure now.

Now, with regard to non-malignant disease at lower levels of exposure. You will remember that I stated that our laboratory undertook a survey of current and former VC-PVC employees at Dow Chemical. I have further detailed to you the valuable information that has been provided by Dow scientists concerning levels of exposure which have obtained in their plant in the past. The results of our Midland survey are still being studied, but I have analyzed data with regard to what seem to be in our hands one of the most sensitive, practical parameters of VC toxicity--that is, elevation of alkaline phosphatase. 108 of the 434 workers tested, approximately one quarter, had serum elevations of this enzyme. The first examination of our survey results also indicates that the percentage of individuals with palpable enlargement of liver and/or the spleen was very much the same as observed in the Niagara Falls group.

Now, I don't want this to be misinterpreted. I am not saying that if you decrease levels to one to five parts per million, you are going to have just as much alkaline phosphatase elevation and just as many enlarged livers and

systems, because some of the enlarged livers and some of the elevations of the alkaline phosphatase and perhaps most of them may have been the result of exposures at higher levels years ago.

But at least it gives us pause when we consider the kinds of levels we are discussing.

With regard to polyvinyl chloride resin, at the New York Academy of Sciences meeting, Lampe and his colleagues, and Wurtsteiler and his, reported cases of classical vinyl chloride disease confirmed by biopsy among workers exposed only to the polymer resin, in secondary PVC production processes. This points to the urgent need for the application of the proposed standard to operations in which the polymer is used. Further, I would urge that industry make every effort to remove residual VC monomer from the polymer resin.

Dr. Volkheimer of Berlin reported at the New York meeting that PVC particles on ingestion rapidly enter the blood stream and lymphatics and that the particles then appear in the urine, in the lung, in the peritoneal cavity, in the mesenterial lymph and in the milk of animals and lactating women. He also demonstrated the transplacental passage of PVC particles. Thus it is often very difficult to prevent the dissemination of fine PVC particles into the environment of a plant--one of the plants

people with esophageal varices, a complete blood count will also pick up anemias at no extra cost to any one and is of potentially great benefit to the patient.

And, finally, in view of our findings on chest X-rays and pulmonary function tests, I suggest that a routine PA chest film be done as ordinary standard ventilatory pulmonary function studies. This addition would also cover the possibility, suggested in the data of Dr. Tabershaw and Dr. Gaffey, that pulmonary neoplasms are increased in incidence among vinyl chloride workers.

Finally, with regard to exposure of women, the demonstration by Dr. Maltoni that exposure of pregnant rats to vinyl chloride from day 12 to day 18 of pregnancy--one week--may result in angiosarcoma in the offspring, indicates that women in the childbearing age should not work in any area in which there are detectable levels of vinyl chloride. This should be made a hard and fast rule.

Thank you very much for the opportunity of appearing before you.

JUDGE MYATT: Thank you, Dr. Selikoff and Dr. Nicholson. Mr. Klein?

MR. KLEIN: Your honor, I had two very short questions and then Dr. Lassiter I believe may have some questions as well.

Directing your attention to the Maltoni animals

that had been exposed for 17 weeks, and your optimism as to the existing workers, would it be your view that employees could be exposed to vinyl chloride for a period of time without an angiosarcoma hazard?

DR. SELIKOFF: Yes, I think that if there is only short exposure, the risk of developing angiosarcoma is less. This is standard. It is standard with asbestos, it is standard with betanaphthalamene, it is standard with benzidene--it is standard with many carcinogenic substances.

The shorter the exposure, the less the risk--not that there is no risk. There may be significant risk, but it will be less. And I think our task is to try to get that risk as close to zero as possible, although we realize that we may not get it to zero.

MR. KLEIN: Now, I would like to direct your attention to repair mechanisms after a so-called onslaught. Do you know if there is any evidence as to whether the body mechanisms can repair after being hit by carcinogenic substances?

DR. SELIKOFF: I think so. I don't know whether the repair can occur after the carcinoma has begun, but I don't know if we have closed the books on that. For example, among cigarette smokers--I don't know if this is totally applicable, but it is a suggestion--among cigarette smokers, those who stop smoking for the first year have exactly the

are still a few papers that we haven't even received. We have received most of them. And I am confident that if you were to contact the editorial department of the New York Academy of Sciences and if they were to ask me in a nice way, I would see that you did get the papers that we do have.

DR. LASSITER: Thank you very much, that saves me some of the questions I had. You covered quite a bit of ground in some of the studies both of a biochemical nature and of an epidemiologic nature.

I had a couple of questions on some of your earlier presentation in which you mentioned a possible transport mechanism of vinyl chloride. Do you feel that this would be a mechanism that would, say, transport vinyl chloride throughout the blood stream to the liver, and you would hypothesize that this might be the primary means of transport?

DR. SELIKOFF: This is an hypothesis that is being advanced by Dr. Cecav of our School, who did this work. It is one lead, but obviously there is so much work that has to be done, we have only begun to look at this problem, and there may be additional hypotheses equally valid.

DR. LASSITER: Okay, thank you. Also in your test for chromosome breaks, are you using bronchial epithelium, or which tissue are you using?

DR. SELIKOFF: No, we are using blood lymphocytes. We are doing chromosome breaks and also chromosome particles. We are beginning a fairly extensive study of the potential for mutagenicity of vinyl chloride. There are a number of test systems that we are beginning to employ. I mentioned the Drosophila test, there are others. And these are under the direction of Professor Hirshhorn in our School.

DR. LASSITER: Also you were mentioning the possibility that PVC might play an important role and perhaps more so than vinyl chloride, did I interpret that correctly, or is it the vinyl chloride absorbed on PVC you're talking about?

With regard to the lung,

DR. SELIKOFF: I just don't know. These people had exposure to VC but they also had exposure to PVC particles and our findings with regard to the lung are simply those in workers that have been exposed to both. At this point I would rather not hazard a guess.

DR. LASSITER: Was your [illegible]coniosis effect that you observed due to PVC dust?

DR. SELIKOFF: I can't tell you, these people were exposed to both. In the one study in which there is histological material, PVC particles were found in the granulomas on biopsy. But I don't know if that is a red herring or not. The scarring may have been there due to the vinyl chloride and the PVC particle may simply be present. I suggest that we withhold judgment on this matter until

further information becomes available.

DR. LASSITER: All right, I missed the analogy between angiosarcoma and misothelioma. Was it simply the fact that you have seen more of the former?

DR. SELIKOFF: Taking duration from onset into account, the number of hemangiosarcomas per thousand person-years at risk is greater for hemangiosarcoma than for misothelioma among asbestos workers.

But I caution against putting too great weight on these data. I simply presented them because they are the only data available.

But the numbers are small with regard to the vinyl chloride and I think that before any definitive judgement can be made on this very interesting comparison, we again should await the collection of more information.

DR. LASSITER: Could you possibly make available your studies--or maybe you have--on the Union Carbide/Dow (?) that you mentioned. Do you have this as part of the record.

DR. SELIKOFF: No, we haven't added up our results. My poor colleagues have gone off on a well-earned vacation these past two weeks, they were exhausted after examining over 1200 vinyl chloride workers, and I relented and allowed them to take off the ten days or two weeks.

DR. LASSITER: When do you suppose these studies

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might be available?

DR. SELIKOFF: I will convey your urgency to them upon their return.

DR. LASSITER: Thank you.

JUDGE MYATT: Anything further from the Government's table?

MR. KLEIN: Nothing further, your honor.

DR. SELIKOFF: Dr. Nicholson just said that some got away, he didn't.

JUDGE MYATT: Questions from the floor?

MR. HECKMAN: I hope you will bear with me, your honor, I have got questions that have been forwarded to me by a number of the other parties.

Dr. Selikoff, were you present earlier today when I inquired of Dr. Key about the nature of angiosarcoma and its diagnosis, etc?

DR. SELIKOFF: Yes, sir.

MR. HECKMAN: My name is Jerome Heckman, I am general counsel for the Society.

Would you like me to start that question again?

DR. SELIKOFF: No. You asked Dr. Key about the difficulty of diagnosis.

MR. HECKMAN: And I was just wondering if you would be in general agreement with most of what he said?

DR. SELIKOFF: No. It would be very difficult for

me. My pathology training goes back to 1941, but Dr. Pepper tells me it is not difficult for him.

MR. BERMAN: I understand that.

(Continued)

I think he said there are certain people who are more susceptible than others. But it is not a disease that is readily recognized by a great number of physicians, is that correct?

DR. SPENCER: By a great number of physicians you are correct. By a great number of pathologists, I am not sure. I think capable pathologists are able to diagnose this in most instances.

MR. BERMAN: Would you care to give me an estimate of the number of people who are autopsied when they die from [illegible]

DR. SPENCER: [illegible] small [illegible] by the [illegible] I only [illegible] probably autopsies but with the [illegible] specific [illegible] in any area.

[illegible] 15 to 25 percent of the people.

MR. BERMAN: But it is [illegible] impossible to [illegible] because of the [illegible] autopsy and pathology, [illegible]

DR. SPENCER: Oh, no, it can be diagnosed by

biopsy as well.

MR. BECKMAN: But the most frequent way in which it has been diagnosed recently is by pathology and rather complicated slides.

DR. SELIKOFF: They are not complicated slides at all. They are standard histological sections.

MR. BECKMAN: But you do have to make slides and analyze them?

DR. SELIKOFF: Sure, you cannot do it without histological material.

MR. BECKMAN: Do you agree in concert with Dr. [illegible] about the possibility of confusion of other liver [illegible] with angiosarcoma.

DR. SELIKOFF: No question about this.

MR. BECKMAN: Is it not true that roughly about 50 years ago lung cancer was considered a fairly rare disease?

DR. SELIKOFF: Not only was it considered to be a rare disease, but it actually was a rare disease. We didn't begin a nation of cigarette smokers until after the First World War. Many people consider that this was due to the sending of the millions of cartons of cigarettes to our fighting overseas by the American Red Cross in the First World War.

(Laughter)

DR. HICKMAN: Unfortunately, I happen to be one of those. You are not making me feel good.

The fact is, though, that it is likely, is it not, now that more attention has been focussed on angiosarcoma, we are apt to get more diagnoses of it in a general population as well as in the worker population?

DR. SELIKOFF: No doubt about that. In fact, I think in the next period it is probably going to be over-diagnosed. Every pathologist who has been reading the medical press, or the lay press, especially the Wall Street Journal and the New York Times, are very much aware of this [illegible] is possible that it may be over-diagnosed. Until it [illegible] until we get in back of the center--it [illegible] settles in the center, it always keeps vibrating.

DR. HICKMAN: Sort of like tuberculosis?

DR. SELIKOFF: Yes.

DR. HICKMAN: Dr. Selikoff, as a practicing physician [illegible] you are, if the PVC industry were [illegible] would you have concern as to the circumstances, so to speak, in light of the fact that my understanding is -- and you might want to correct this -- is that a great deal of blood technology and IV technology other than that [illegible] on the PVC industry.

DR. SELIKOFF: As a practicing physician I have

people tell us that they have never seen such a level except in the presence of cancer--and yet the man feels perfectly well. So he has been admitted to the hospital to be examined, Roswell Park has just discharged him with the admonition to come back every month. They couldn't find anything either and they, as we, are keeping our fingers crossed.

MR. HECKMAN: But you are taking steps to notify these people if they have disease?

DR. SELIKOFF: Each man will receive an individual form, a letter, with details of every single test that has been done and with the request from us that we be allowed to give these results also to the Goodyear Company. We will not give it to the company, however, without the permission of the worker.

MR. HECKMAN: On page 7 of your testimony, you indicated that you were pleasantly surprised to find that humans were not showing the same hypertension and urinary diseases as showed up in some of the Haltoni data with regard to the rats.

DR. SELIKOFF: Let me correct that, I may not have made myself clear. The hypertension was reported by Suceau of the city of Cluges in Rumania. We did not confirm his finding.

Now, he may have been looking at different people or using different criteria.

The kidney tumors were reported by Dr. Maltoni in rats--and I don't know whether they will eventually occur in humans or not. At least to the present, we have found no evidence for this.

MR. HECKMAN: And so to some extent that does further give you pause about relating the animal data to the human data?

DR. SELIKOFF: Yes, I don't think that you can automatically translate animal data to human beings, I don't think this at all.

MR. HECKMAN: With regard to that Goodyear experimentation in general, there are many places in the testimony where it is not clear to me, although it may be to many other people, as to whether the figure for some of the diseases, how they relate to general population? Are you indicating in all of those cases that the general population figure is lower?

DR. SELIKOFF: Yes, we made clear that we had a number of liver function tests which were abnormal. For example, I said that six percent of the people had more than 1.1 milligrams of bilirubin, which in our laboratory is considered top limit of normal.

But then again there are other diseases which can do this, or conditions, for example Gilbert syndrome, which occurs in the general population in a few percent of the

people can also give serum bilirubin of this type. So that when we found that in only six percent, I am not regarding this as evidence of liver disease.

And you will always find some people with an elevated alkaline phosphatase or SGOT and so forth--it has got to be more than just a few percent.

The levels that we found in Niagara Falls, however, were way beyond the range that we find in our general population.

MR. HECKMAN: I would like to direct your attention, if I may, to that table on page 12 of your testimony. That table bothers me a little bit. If I understand it correctly--I realize that it is a mathematical exercise to some extent.

But if I understand correctly, you took one plant and developed the figures for the persons and years at risk with respect to vinyl chloride. And the asbestos data is gleaned from four plants.

And therefore we are really not comparing apples and apples here.

You did not take into account the many PVC and VC plants where no deaths had been reported, is that true?

DR. SELIKOFF: You are absolutely right. I wish we had data like this in other plants, but this is the only plant that has so far been thoroughly studied with 99 percent

current and former vinyl chloride workers and have given us the results of all these studies.

MR. HECKMAN: Fine, I think possibly you will hear that in due course.

On page 15, you indicate that you really believe that it is technically feasible for the industry to comply with this proposed permanent standard that OSHA has put out so far.

DR. SELIKOFF: I do. You know, you people have only been looking at this for a few months. This came as a surprise to most of you--and I think there is a world of achievement ahead of you, there is a world of engineering achievement that you can look forward to.

Mind you, it may be economically difficult and it may be that the difficulty is going to be so great, the pressures so fierce, that a safe standard will not be set and that we are going to have to learn to live with cancer. I hope that this is not going to be the case.

MR. HECKMAN: I gather, from what you just said, that you have some understanding of theneed for patience with industry provided it indicates that it will do everything humanly possible to try to bring the level down as low as possible as soon as possible.

DR. SELIKOFF: I would be absolutely patient if those commitments are made, that you will do everything

possible--not everything possible up to the limit of spending money, but everything possible, everything humanly possible, everything as rapidly as possible--I would be as patient as Job.

MR. HECKMAN: Thank you very much.

MR. TOPOL: Did you conduct an examination of the Tenneco employees at their Plumbington, New Jersey, plant?

DR. SELIKOFF: No. I examined a small number, as I said, of Tenneco workers in our field station in Patterson, New Jersey, not at the Tenneco plant.

MR. TOPOL: Do you have the results of those studies?

DR. SELIKOFF: I don't have them here, no.

MR. TOPOL: When you have them, will you make them available for the record?

DR. SELIKOFF: Surely. In fact, as we give them to the workers, I will be delighted to give them to the Tenneco Company also. I have already spoken to Mr. Lamb of the Tenneco Company about this. And I have promised that with the approval of the workers these data will be made available to him.

MR. TOPOL: When did you first know that there were three cases of angiosarcoma at the Goodyear-Niagara plant, before you went up for your visit or did you subsequently learn that?

liver, various causes, but you don't find a palpable spleen, and in Niagara Falls we found over 3 percent with palpable spleens. This is very unusual.

But, as I said, we found it less frequently than the Germans found palpable spleens in the University of Bonn study.

MR. TOPOL: I think you made the statement during your testimony or during questions, that the only safe level is zero. By that I gather you mean that based on the current state of knowledge we can't say whether low levels are safe or unsafe, would that be a fair statement?

DR. SELIKOFF: Absolutely. The only level that we know is safe is zero. It may turn out that 2 parts per million we will see one case in 50,000 or one case in 20,000--I don't know this. The only thing I know at this moment--we are ignorant as all get-out so far.

MR. TOPOL: You mean ignorant on the question whether low levels would be safe or unsafe?

DR. SELIKOFF: That is right. The question is, what do you do in the absence of knowledge?

MR. TOPOL: You said, in that connection, that you thought that the shorter the exposure in terms of time duration, the lower the risk.

Would that be true also for the level of exposure --that is, the lower the level of exposure, the lower the

risk?

Dr. GELLHORN: Yes. That is generally true in human carcinogenesis, for example, people who smoke two cigarettes a day have virtually no excess risk of lung cancer against somebody who smokes three packs a day.

MR. TOPOL: Two additional questions.

On the 19 expected deaths, versus the 24 that occur in the mortality, this is in the mortality study that Dr. Nicholson talked about, what sort of confidence interval do you put on that expected deaths? I mean, is there a statistical difference between the 19 and 24, or is the variability in those so great that there really is not a statistical difference? How do you relate it?

DR. NICHOLSON: It wouldn't be statistically different at the 5 percent level, which is the level that statisticians typically like to speak about. The 19 calculated deaths are very accurate. They are using the --.

The 19 calculated deaths were obtained using the mortality data of the region about that plant, that is northern New York State.

So that's an accurate figure. But 24, of course, has a variability associated with it, if one did a similar study, statistically you'd expect a different number. And it may be more or less.

I might note, though, the point that was made earlier by Dr. Lloyd, that when one goes in and does an epidemiological study of a working population, one typically finds perhaps only 80 percent of the mortality that one would calculate from the general population data, so that a better comparison would be perhaps with a number of 15 or 16, and there

it would become statistically significant.

MR. TOPOL: But in this case it is not as statistically significant, then?

DR. NICHOLSON: At the five percent level, that is correct.

DR. SELIKOFF: Even if it were statistically significant, I don't think too much weight should be placed on it. The numbers are very small, and with small numbers, I think we need more data.

MR. TOPOL: Okay. Let me ask you my final question. In the three cases of angiosarcoma at the Buffalo-Niagara plant, which you studied, do you have any idea, based upon the jobs of those people or any other information you got from the manufacturer involved as to the levels of vinyl chloride exposure to which those employees were exposed, and over what period of time?

DR. NICHOLSON: The periods of exposure I gave you, they were 14, 17 and 23 years the men worked, from beginning of employment to shortly prior to death.

MR. TOPOL: And in which years were those, in the Forties, the Fifties, or what?

DR. NICHOLSON: They began employment prior to 1951.

MR. TOPOL: All three?

DR. NICHOLSON: Just a moment and I can give you the detailed histories.

The dates of onset were 10/46, 10/47 and 6/51, with dates of deaths respectively 3/70, 8/61, and 5/68.

They all worked predominantly in the PVC production facility, that is, they were not maintenance employees. They would have progressed through -- perhaps these men for only a short time -- through a bagging facility where they would, in that operation, also be required to clean reactors; and they may have been involved in reactor cleaning on overtime.

So that exposures could have been -- they could have experienced peak exposures that would have been quite significant. We had evidence of such peak exposures i current work force.

As to the average levels that they were exposed to, it is very hard to estimate. We have no data on that whatsoever.

MR. TOPOL: When you say a significant exposure, what do you mean, in terms of parts per million?

DR. NICHOLSON: Well, I would estimate that in some of the -- well, from data on other employees reporting symptoms and dizziness, lightheadedness, even loss of consciousness, that some employees at some time in those plants could have been exposed to concentrations in excess of 1,000 parts per million.

I don't know if any of these were, because we couldn't, of course, interview them. But such exposures for short periods of time did take place in that facility.

MR. TOPOL: Thank you very much.

We're going to tidy up all the things, all the untied strings that are lying around, we're going to amuse ourselves with studies, and we're going to ask our basic scientists, we're going to ask Perry Gehring, for example, to give us the mechanism of this, because it will help us in other things.

But, by and large, the question of the importance is simple. When three out of 24 deaths in one group are due to hemangiosarcoma, one out of every eight deaths, and another one due to liver scarring with sophogeal varices, in a man who didn't drink very much, by the way, well, this is important.

Now, let's say that not one single cancer-more is going to occur in these 255 people, that it's only going to be three. We've seen everything we're going to see. Still, the even one percent of deaths in that population is a very important thing, when it shouldn't be anything at all.

So that that part of the problem is settled.

The part of the problem that is not settled is what basically you people are discussing here today: how do we control it?

MR. SAMUELS: On behalf of the workers, Doctor, thank you.

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JUDGE MYATT: Yes, sir?

MR. ARMSTRONG: I'm Paul Armstrong, with Georgia Pacific.

Dr. Selikoff, you mentioned the use of time weighted

averages by Dow in control levels. You've been quoted a couple of times on "the shorter the exposure, the lower the risk".

Putting those two together, I got to thinking about -- supposing you had a very short period of some modest level, how serious would that be?

Let's take examples, like you had a 50 part per million exposure of a worker on a random basis, once a week, and the rest of the time it was at the prescribed level. Is that important, and could a time weighted average be set up along those lines that would give full protection?

DR. SELIKOFF: Well, I think 50 parts per million is huge. You even -- at 50 parts per million at Dow, you even found, in your laboratory, liver damage. Without cancer. And fairly short studies -- it was about, what, six months' exposure?

MR. ARMSTRONG: Perhaps I don't make myself clear. Let's say for a period of one minute once a -- at a period of, say, every week or something like that, on a random basis. The point is that you have a plant and your conditions are well controlled, but occasionally, due to operator error or something else, you have a chance that's on the level of being almost unpreventable; do you put your people in air masks all the time, or could you justify this on a time weighted average, that your additional damage/would be done by this risk that was so low as to be not worth the additional prevention?

DR. SELIKOFF: I don't think that anything is going to occur there that for one minute you're going to put anybody in a respirator. By the time he got the respirator, that minute would be over.

But your basic principle is correct. The lower the exposure, the shorter the exposure the less the risk.

And I am hopeful that we will have exposures so short and so low that the risk is going to be infinitesimal.

MR. ARMSTRONG: Thank you.

JUDGE MYATT: Yes, sir?

MR. CONNOLLY: Dr. Selikoff, is there any comparison that can be drawn between exposure to asbestos, to fibers, and some figure of exposure to polyvinyl chloride?

DR. SELIKOFF: No, I don't think there can be, they are two different things, they work differently. Except that they both can cause cancer.

But -- in that way, they are very much alike.

MR. CONNOLLY: Is it your feeling that, for instance, exposure to asbestos ought to be at the zero level also?

DR. SELIKOFF: Oh, sure; I'd love it to be.

MR. CONNOLLY: I see.

DR. SELIKOFF: I don't think anybody should inhale asbestos, just as I don't think anybody should inhale vinyl chloride.

MR. CONNOLLY: Now, if you would turn to page 12 of

your very sophisticated presentation, I would like for you to assume a couple of facts for me.

If you were to assume that the person-years at risk in the area of VC were, say, the same figures as in the area
277 of asbestos -- in other words, say you had a 20,000 figure, and also assume that in a number of deaths there were, say, ten deaths, and it was spread out roughly comparable to the way the Goodyear plant is spread out: Would you think that the comparison between exposure to vinyl chloride would be comparable, in terms of the results, as in comparison to the results in the asbestos?

DR. SELIKOFF: I can't tell you. As I said before, the numbers are so small that I wouldn't want to go hazard guesses. We need data instead of guesses.

I've given you the best we have, but it's not good enough.

MR. CONNOLLY: So that, in your opinion, there's no question that we need additional research in this area?

DR. SELIKOFF: Oh, sure.

MR. CONNOLLY: Additional data.

DR. SELIKOFF: You wouldn't expect a scientist to answer that we don't need additional research.

[Laughter.]

MR. CONNOLLY: Now, isn't it true that at the Goodyear plant, that you studied, that they have a significant

amount of chlorine in the plant?

DR. SELIKOFF: This I can't tell you. I'm sure the Goodyear people can tell you this.

DR. NICHOLSON: Only when they made the monomer test.

That was only a possibility, prior to 1960, I believe, when they made the monomer.

278 I don't believe that would have been present to any extent subsequent to that.

MR. CONNOLLY: Now, let me ask you this question --

DR. NICHOLSON: I could be corrected by somebody from Goodyear, but --.

MR. CONNOLLY: On the basis of the preliminary data that you have, can it be said that such a comparison could be made between vinyl chloride and asbestos can be significant as of this juncture? Or is it in fact insignificant, and you need more data before you can make a valid comparison?

DR. SELIKOFF: I don't think the comparison is well based, yet. I have given you the information that we have, which points to the fact that this -- if the data continue -- that's the way we always talk -- if the data continue in the same direction, vinyl chloride is going to be significantly more hazardous than asbestos.

But the new data may be different. We may find, next year, that everything is going to be marvelous. I doubt it, but --.

MR. CONNOLLY: Well, there is a possibility what with added research we will be able to pick a level of exposure that's safe, then?

DR. SELIKOFF: Anything is possible. You know, the only unhappy thing, as Professor Mathison used to say, there are many roads to Utopia, but unfortunately all of them must traverse the surface of the earth.

MR. CONNOLLY: Well, I'm sure Professor Mathison, if he were here, would be happy to hear you say that.

[Laughter.]

Have you or anybody in your organization had an opportunity to examine Maltoni's recent slides?

DR. SELIKOFF: No.

MR. CONNOLLY: In other words, you're basing your conjecture on the telegram that Maltoni has sent you? Or sent to NIOSH, which you were --

DR. SELIKOFF: Dr. Maltoni visited me in my laboratory on June 6, and told me about that 50 part per million observation. I haven't seen the animals myself.

However, I can give you an advertisement for the JOurnal of Environmental Research, in the June -- it will be out in July -- the June issue, there will be an article by Professor Maltoni, with some 20 color plates, giving the details of the histological sections and the gross appearance of the tumors in animals.

MR. CONNOLLY: I understand that Dr. Popper went to see Maltoni recently in Italy; are you familiar with that?

DR. SELIKOFF: Yes.

MR. CONNOLLY: Are you familiar with the fact that Maltoni refused to allow Dr. Popper to see his slides?

DR. SELIKOFF: Gee, I'd hate to have you make such a mistake elsewhere. I'll tell you what actually happened.

Dr. Maltoni went to Milan, he didn't go to Bologna. He had to go to Milan for a liver meeting, and it was hoped that Dr. Maltoni would meet him in Milan; unfortunately, Dr. Maltoni was ill and didn't go to Milan. But Dr. Popper did not go to see Dr. Maltoni, and Dr. Maltoni did not refuse to give him his slides. There's been a little difficulty here.

MR. CONNOLLY: But, in any event, no one in your

280 organization has ever seen Dr. Maltoni's slides?

DR. SELIKOFF: No, I've never seen it, Dr. Popper has never seen it. I don't know.

MR. CONNOLLY: Would you say that time is necessary -- by time, I mean --

DR. SELIKOFF: I think Dr. Torkleson, though, saw them, didn't he, from Dow? Didn't a number of U.S. scientists go to see Dr. Maltoni in January of '73, and saw slides? That's my understanding; I don't have firsthand information.

MR. CONNOLLY: I can't speak for Dow.

Is it safe to say that American industry, the

polyvinyl chloride industry is some time away from getting to a low level, such as you're proposing? That it will take some significant amount of time, research, changes in engineering and technology, and vast sums of money to get to the level you are proposing?

DR. SELIKOFF: I think it's going to take time, and it's going to take money. I agree with you. Yes, sir.

MR. CONNOLLY: And it would take -- your estimate would be that it would take years to get to that?

DR. SELIKOFF: I have no estimate; I'm not an engineer.

MR. CONNOLLY: I see.

I have no further questions. Thank you, Doctor.

JUDGE MYATT: Are there any other questions?

Mr. Samuels.

MR. SAMUELS: If there were no Maltoni data at all, would you still come to the same conclusion about the risk of vinyl chloride?

281 DR. SELIKOFF: If there were Maltoni data, and we didn't see the human cases, I'd be less secure. The human cases give the results far beyond the animal experiments. The animal experiments are important, because they have shown us that the toxicologists in the future are probably going to be able to predict tumors before we see them in humans. Very valuable from a scientific and theoretical aspect.

MR. FLEMING: I think that's interesting.

Now, one other thing. I think it is clear that the principal cause of concern that has brought about this meeting is angiosarcoma.

DR. SELIKOFF: Yes, sir.

MR. FLEMING: And you have repeatedly stated that there is no safe level.

DR. SELIKOFF: That we know of.

MR. FLEMING: But with respect to angiosarcoma, I think that Dow has presented a rather thorough study of workers exposed at levels well over 100 parts per million for rather long periods of time, with no incidence of angiosarcoma. The very data you're talking about.

Is that a true representation?

DR. SELIKOFF: I haven't seen those data. I would be delighted to see a study of all their vinyl chloride workers -- not their current work force, but their vinyl chloride workers from the time they began to make VC or PVC, and have traced them to determine their current status, and to let us know what their current status is. This is pretty significant information.

MR. FLEMING: But you have surely seen the published reports by Dow, you've seen their studies.

DR. SELIKOFF: But they have nothing to do with long-term observation of their workers. Unless there are studies

that I don't know about that have been published. I doubt this, because I think I know the Dow-published material.

Are you aware of such a study?

MR. FLEMING: I have the impression that these people were studied over long periods of time.

DR. SELIKOFF: I would be delighted if you would tell me of a study by Dow that's been published, in which they have followed their vinyl chloride workers and determined, at a point in time, what their status was. Especially workers who had gone more than 15, 20, 25 years from onset of exposure. These are very important data.

MR. FLEMING: Yes. Okay.

Perhaps Dow will elucidate on that later, I don't know. I thought that was already well-established.

DR. SELIKOFF: No, that has not been established. At least not to -- I've never seen such a paper.

MR. FLEMING: All right. Thank you very much.

JUDGE MYATT: Are there any other questions?

All right, Dr. Selikoff, I am going to enter into the record as Exhibit 18-A the article, Prevalence of Disease Among Vinyl Chloride and Polyvinyl Chloride Workers; and as 18-B, Mortality Experience of a Cohort of Vinyl Chloride and Polyvinyl Chloride Workers; and as 18-C, Dr. Selikoff's statement.

[Documents referred to were marked

PROCEEDINGS

JUDGE MYATT: All right, This hearing is resumed.

The next witness is the representative of Prevue Products.

Proceed, sir.

MR. COHEN: Thank you. Good Morning.

My name is Zvi Cohen. I am the President of Prevue Products, Incorporated, of Manchester, New Hampshire. Prevue Products is one of the largest manufacturers of slush molded waterproff footwear in the United States.

Over the past decade slush molded footwear has become the most popular form of protective outer footwear in the United States, Especially for women and children. This process of making waterproof footwear has almost entirely replaced the conventional handmade method of making such footwear. The skills required to make waterproof footwear in the traditional fashion by the autoclave vulcanizing method have all but disappeared in this country.

There are fewer than ten manufacturers of slush molded footwear in the United States, and all authoritative estimates put the total production per year at approximately 10 million paid. In view of the fact that these boots last for a long time, it is probably true that most women and children who buy protective footwear in the snow belt of the United States are consumers of slush molded footwear.

Every pair of slush molded footwear requires PVC resin as its primary component. There is no substitute for PVC in the slush molding process, since no other material has the same manufacturing characteristics. If PVC were to become unavailable, not one pair of slush molded boots could be produced in this country.

We have recently had an independent laboratory conduct tests in our plant which indicate that the level of VC in our operation is less than one part per million. Of course, this is to be expected since we are working with PVC resins rather than with VC itself.

We believe that our current level of VC constitutes no health hazard. We do not know how we could achieve any reduction below that current level. However, our suppliers have told us that if the one part per million standard were to be imposed upon them, it would be impossible for them to continue their operations. What they have told us is that something between the emergency level which was set on April the 5th, 1974, and the one part per million proposed standard could be attained in a reasonable time.

The prospect for my industry should the one part per million standard be imposed is a very bleak one. In my factory there are 500 people who would be thrown out of work should PVC resins become unavailable. Instead of the steady employer which we have been for the past nine years, we would suddenly

become no employer at all in our area. Even a reduction in our supply could gravely affect our operations, because volume is the key to our profitability.

I urgently request that the Occupational Safety and Health Administration attempt to work out a reasonable VC standard for the PVC industry which will enable our industry and many others to continue in business through a continuation of the PVC resin supply, consistent with human safety.

Thank you.

JUDGE KLEIN: Mr. Klein.

MR. KLEIN: I have a very few brief questions for you.

What process or processes do you use in making your product?

MR. COHEN: Well, it's known as the slush molding process. It's a diminishing form of molding.

MR. KLEIN: Do you heat the resins to make the slush--

MR. COHEN: Well, first we mix the resins with plasticizers to make plastisol, and then we apply heat to cure it.

MR. KLEIN: Did you do your own measuring of --

MR. COHEN: No, we had an independent laboratory do the measuring.

MR. KLEIN: Over what period of time did they take those measurements?

MR. TOPOL: Thank you very much.

Ex 20A

STATEMENT OF JOSEPH F. TOMASHEFSKI, M. D.
HEAD OF PULMONARY DISEASE DEPARTMENT
OF THE CLEVELAND CLINIC
PREPARED FOR PRESENTATION AT
DEPARTMENT OF LABOR HEARINGS ON
VINYL CHLORIDE;
OCCUPATIONAL EXPOSURE STANDARD
JUNE 25, 1974

JUDGE MYATT:

My name is Joseph Francis Tomashefski. I am a physician, a specialist in pulmonary diseases and in environmental medicine. My present position is that of Head of the Pulmonary Disease Department of the Cleveland Clinic where I also supervise respiratory therapy and the pulmonary function laboratory. In addition, I hold the rank of Clinical Professor in the Department of Preventive Medicine at the Ohio State University College of Medicine. I have held past appointments, such as Chief of Research and Director of the Cardiopulmonary Laboratory, Inhalation Therapy Department of the Ohio Tuberculosis Hospital in Columbus, Ohio. In the period between 1967 and 1971

I WAS WITH BATTELLE MEMORIAL RESEARCH INSTITUTE IN COLUMBUS OHIO AS ITS MEDICAL DIRECTOR. IN THIS CAPACITY I WORKED VERY INTIMATELY WITH SAFETY AND INDUSTRIAL HYGIENE PERSONNEL ON RESEARCH PROJECTS PERTAINING TO CHARACTERISTICS OF RESPIRATORS. I HAVE BEEN ASSOCIATE PROFESSOR OF PHYSIOLOGY AT OHIO STATE UNIVERSITY AND A FORMER FLIGHT SURGEON IN THE UNITED STATES AIR FORCE. I HAVE PUBLISHED RATHER EXTENSIVELY ON THE SUBJECT OF ENVIRONMENTAL HAZARDS. I HAVE CERTIFICATION WITH SUBSPECIALIZATION IN AVIATION MEDICINE.

MY TOPIC FOR DISCUSSION THIS MORNING IS RESPIRATORS: THEIR VALUE, LIMITATIONS AND HAZARDS.

AIR CONTAMINANTS, BE THEY GASEOUS OR AEROSOL PARTICLES, DEPOSIT IN THE RESPIRATORY TRACT BY ONE OF SEVERAL MECHANISMS: INERTIA, IMPACTION OR IMPINGENCE, SETTLING, BROWNIAN MOVEMENT, OR DIFFUSION. THE POINT OF DEPOSITION MAY BE AFFECTED; HOWEVER, SOLUBLE GASES OR SOLUBLE AEROSOLS ARE ABSORBED INTO THE GENERAL CIRCULATION AND MANIFEST EFFECTS IN MORE DISTANT PARTS OF THE BODY.

AN INHALED CONTAMINANT MAY HAVE A DIRECT EFFECT ON THE RESPIRATORY SYSTEM BY PRODUCING AN IMMEDIATE REACTION SUCH AS AN IRRITATION OR EDEMA OR TISSUE DESTRUC-

TION. ON THE OTHER HAND, THE EFFECT MAY BE LATENT OR IT MAY NOT MANIFEST ITSELF FOR MANY YEARS IN THE FUTURE. EXAMPLES OF SOME OF THE DIRECT RESPIRATORY IRRITANTS OR SUBSTANCES THAT MAY HAVE A DELAYED ACTION ARE ASBESTOS AND BERYLLIUM. IN ADDITION, THE RESPIRATORY SYSTEM MAY ACT AS A PORTAL OF ENTRY FOR A SUBSTANCE WHICH MAY MANIFEST ITSELF IN OTHER ORGANS OF THE BODY AS DO, FOR EXAMPLE, CARBON MONOXIDE, MERCURY, AND LEAD.

BOTH OF THESE ACTIONS ARE TO BE CONSIDERED AS RESPIRATORY HAZARDS. THE PRIMARY DEFENSE AGAINST SUCH HAZARDS IS TO ELIMINATE OR CONTROL THE CONTAMINANTS AT THE SOURCE OF ORIGIN TO PREVENT BREATHING THEM INTO THE RESPIRATORY SYSTEM, OR TO KEEP THE CONCENTRATION OF THE CONTAMINANTS WITHIN ALLOWABLE SAFE LIMITS. THIS CAN BE DONE BY EMPLOYING PREVENTIVE MEASURES, INCLUDING EXHAUST VENTILATION CONTROL AND MONITORING. RESPIRATORY PROTECTIVE EQUIPMENT SHOULD BE EMPLOYED WHEN THE ABOVE PREVENTIVE MEASURES CANNOT BE ACHIEVED, SUCH AS IN SHORT-TERM EXPOSURES IN HIGHLY CONTAMINATED AREAS, IN EMERGENCY SITUATIONS, IN RESCUE MISSIONS AND IN OTHER SITUATIONS WHERE LACK OF SUFFICIENT OXYGEN, THE PRESENCE OF TOXIC GASEOUS CONTAMINANTS, OR WHERE AIRBORN PARTICULATE MATTER IS GENERATED AND CANNOT BE CONTROLLED.

AN INHALATION HAZARD MAY BE ONE ASSOCIATED WITH OXYGEN DEFICIENCY. THIS IS RELATIVELY EASY TO CORRECT BY SUPPLEMENTING THE AMOUNT OF OXYGEN BEING BREATHED. TO PROVIDE ADEQUATE OXYGENATION, MANY TYPES OF EQUIPMENT ARE AVAILABLE SUCH AS REBREATHING MASKS, SELF-CONTAINED APPARATUS, PRESSURE BREATHING DEVICES AND OTHERS. WHERE HIGH CONCENTRATIONS OF OXYGEN ARE NEEDED (AND THERE ARE VERY FEW CIRCUMSTANCES WHERE 100% OXYGEN IS NEEDED) THIS MUST BE GIVEN FROM NON REBREATHING SYSTEMS OR CAN BE, IF HIGH PRESSURE OXYGEN IS NECESSARY, GIVEN WITH HYPER-BAG CHAMBERS.

RESPIRATORY HAZARDS, OTHER THAN OXYGEN DEFICIENCY, CAN BE SUBDIVIDED INTO TWO GROUPS, I.E., PARTICULATES AND GASES, ALTHOUGH THERE ARE CASES WHEN A COMBINATION OF A GASEOUS AND A PARTICULATE HAZARD CO-EXIST. IN SOME OF THE COMBINATIONS A SYNERGISTIC EFFECT MAY OCCUR ENHANCING THE ADVERSE EFFECT OF EITHER OR BOTH THE PARTICULATE OR THE GAS.

THE PARTICULATES, ALSO REFERRED TO AS AEROSOLS, CAN BE SOLIDS OR LIQUIDS. THEIR DEPOSITION AND RETENTION IN THE RESPIRATORY SYSTEM DEPEND UPON THE SIZE OF THE PARTICLE, THE CONCENTRATION, SOLUBILITY, THE DURATION OF EXPOSURE, OTHER CHEMICAL AND PHYSICAL CHARACTERISTICS

AN INHALATION HAZARD MAY BE ONE ASSOCIATED WITH OXYGEN DEFICIENCY. THIS IS RELATIVELY EASY TO CORRECT BY SUPPLEMENTING THE AMOUNT OF OXYGEN BEING BREATHED. TO PROVIDE ADEQUATE OXYGENATION, MANY TYPES OF EQUIPMENT ARE AVAILABLE SUCH AS REBREATHING MASKS, SELF-CONTAINED APPARATUS, PRESSURE BREATHING DEVICES AND OTHERS. WHERE HIGH CONCENTRATIONS OF OXYGEN ARE NEEDED (AND THERE ARE VERY FEW CIRCUMSTANCES WHERE 100% OXYGEN IS NEEDED) THIS MUST BE GIVEN FROM NON REBREATHING SYSTEMS OR CAN BE, IF HIGH PRESSURE OXYGEN IS NECESSARY, GIVEN WITH HYPER-BAG CHAMBERS.

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OF THE SUBSTANCE, AS WELL AS PHYSIOLOGICAL CHARACTERISTICS OF THE RESPIRATORY SYSTEM AND THE ACTIVITY OF THE INDIVIDUAL OR ANIMAL BREATHING THE PARTICULATE MATTER.

NOT ALL AEROSOLS OR PARTICULATES ARE HARMFUL. HARMLESS, FOR EXAMPLE, ARE SEVERAL PARTICULATES SUCH AS TIN, IRON AND ALUMINIUM. HARMFUL PARTICULATES CAN PRODUCE REACTIONS WITHIN THE LUNGS CAUSING PULMONARY FIBROSIS SUCH AS SILICA, ASBESTOS, COPPER AND COAL; PARTICULATES MAY ALSO PRODUCE A NONFIBROTIC REACTION, A GRANULOMATOUS REACTION SUCH AS CAN OCCUR WITH BERYLLIUM.

ANOTHER GROUP OF HARMFUL PARTICULATES ARE THE ORGANIC TYPES SUCH AS MOLDS, COTTON LINTERS, SPORES, AND CANE. THESE PRODUCE INFLAMMATION AND SENSITIVITY REACTIONS WITHIN THE LUNGS, OR OBSTRUCTION OF THE AIRWAYS SUCH AS ASTHMA AND BRONCHOSPASM.

IN ADDITION, SOME PARTITULATES MAY ALSO BE IRRITANTS OR TOXIC INHALANTS SUCH AS CADMIUM, CHROMIUM, FLUORIDE, LEAD, MAGNESIUM, MERCURY, NICKEL, MOLYBDENUM, VANADIUM, ZINC. ONE MAY, AS A RESULT OF INHALATION OF SOME OF THESE MATERIALS, DEVELOP A FORM OF REACTION WE REFER TO AS METAL FUME FEVER.

GASEOUS (I.E., MOLECULARLY DISPERSED) HAZARDS MAY, OR MAY NOT, BE IMMEDIATELY LIFE THREATENING. EXAMPLES

OF GASEOUS TOXICANTS ARE CARBON DIOXIDE, CARBON MONOXIDE, OZONE, OXIDES OF NITROGEN, PHOSGENE, OR PHOSPHINE.

THE SELECTION OF RESPIRATORY EQUIPMENT DEPENDS UPON THE CLASSIFICATION OF, AND THE TYPE OF HAZARDS FOR WHICH IT IS TO BE EMPLOYED. AMONG THE FACTORS TO BE CONSIDERED ARE WHETHER THE HAZARDS ARE IMMEDIATELY DANGEROUS, WHAT THE CONCENTRATION OF THE CONTAMINANT IS, THE PARTICLE SIZE OF THE CONTAMINANT, WHETHER THE RESPIRATORY EQUIPMENT IS GOING TO BE USED AS EMERGENCY EQUIPMENT OR IS TO BE USED ON A DAY-TO-DAY BASIS, AND THE DURATION OF THE USAGE (WHETHER IT IS ONE HOUR OR EIGHT HOURS PER DAY).

BASICALLY, THERE ARE THREE TYPES OF RESPIRATORS THAT CAN BE EMPLOYED: (1) THE AIR PURIFYING, FILTER, CHEMICAL CANISTER GAS MASK TYPE; (2) THE AIR-SUPPLIED HOSE MASK, WITH OR WITHOUT BLOWERS; AND, (3) THE SELF-CONTAINED BREATHING EQUIPMENT WHICH OPERATES PREDOMINANTLY IN A NON-REBREATHING MANNER, UTILIZING VALVED COMPRESSORS OR CYLINDER AIR SOURCES.

THE AIR PURIFYING TYPE (CLASS 1) ARE USED TO REMOVE CONTAMINANTS FROM AN ATMOSPHERE THAT CONTAINS AN ADEQUATE CONCENTRATION OF OXYGEN. IN OTHER WORDS, WE ARE NOT SPEAKING HERE OF SUPPLEMENTAL OXYGEN ADMINISTRA-

TION. THEY WORK BY EITHER FILTRATION, BY ADSORPTION, OR BY A CHEMICAL REACTION TO REMOVE THE CONTAMINANT. ALTHOUGH NOT OF DIRECT CONCERN IN THE PRESENT CONTEXT, IT SHOULD BE NOTED THAT RESPIRATORS INTENDED TO FILTER PARTICULATES OFFER NO PROTECTION AGAINST GASES OR VAPORS.

AIR PURIFYING RESPIRATORS PRODUCE HIGH RESISTANCE TO BREATHING. ADEQUATE FIT TO THE FACE CONTOUR BECAUSE OF DIFFERENCES IN SIZE AND SHAPE AND ANTHROPOLOGICAL CHARACTERISTICS IS OFTEN A PROBLEM; AND MANY TIMES MASKS MUST BE MOLDED TO THE INDIVIDUAL CHARACTERISTICS. AS A RESULT, LEAKAGE CAN COMMONLY OCCUR WITH THE WEARING OF SUCH MASKS UNLESS ADEQUATE PRECAUTIONS ARE TAKEN.

AS MENTIONED, RESISTANCE TO BREATHING EXISTS. INCREASING THE WORK OF BREATHING COULD PUT A MORE SEVERE DEMAND ON THE RESPIRATORY SYSTEM AND DECREASE THE EFFICIENCY OF PERFORMANCE. TO PREVENT THE CLOGGING OF THE CANISTER AND TO DECREASE THE RESISTANCE TO BREATHING IT IS PERMISSIBLE TO REMOVE THE FILTER WITHIN SUCH UNITS WHERE PROTECTION AGAINST PARTICULATES IS NOT REQUIRED.

THE RESISTANCE IS PRODUCED BOTH ON INSPIRATION AND ON EXPIRATION, THUS INCREASING APPRECIABLY THE WORK OF BREATHING. AS A RESULT OF THE ABOVE INADEQUACIES, MOST WORKERS DISCARD FILTER-TYPE MASKS, REFUSE TO WEAR THEM, ESPECIALLY IF THEY CAN'T SEE THE DUST; YET, THIS FINE, NON-VISIBLE DUST MAY BE THE MOST HARMFUL.

THE CHEMICAL CARTRIDGE TYPES ARE HALF FACE MASKS AND HAVE EXHALATION VALVES. THE CARTRIDGE IS FILLED WITH CHEMICALS SUCH AS ACTIVATED CHARCOAL, SODA LIME, OR SILICA GEL FOR THE ELIMINATION OF THE CONTAMINANT. THEY HAVE VERY LIMITED APPLICATION AND ARE OF VALUE WHEN USED AGAINST VAPORS AND GASES OF LOW TOXICITY.

CANISTER TYPE MASKS HAVE ATTACHED TO THEM A CANISTER CONTAINING AN ADSORBANT. SUCH MASKS ARE OF VALUE IN PROTECTION AGAINST ORGANIC VAPORS, ACIDS, AMMONIA, CARBON DIOXIDE. THEY ARE VERY EFFECTIVE AND THEY CAN PROVIDE EFFECTIVE AND RELIABLE PROTECTION. THE PROTECTION DEPENDS UPON THE CANISTER AND UPON ITS CONTENTS. THE GAS MASKS OFFER APPRECIABLE RESISTANCE TO BREATHING.

THE SECOND GROUP OF RESPIRATORS MENTIONED WERE THE AIR-SUPPLIED RESPIRATORS, THE TYPE THAT HAS A HOSE CONNECTED TO AN UNCONTAMINATED AIR SOURCE. THESE MAY

BE EQUIPPED WITH OR WITHOUT BLOWERS. THEY MAY HAVE AN AIRLINE ATTACHMENT FOR CONTINUOUS FLOW OR FOR USE AS DEMAND-TYPES OF RESPIRATORS. THEY MAY BE USED WITH A FULL FACE MASK, WITH HOODS, OR WITH FULL BODY SUITS. THEY ARE USUALLY EMPLOYED FOR SPECIFIC TASKS OR FOR HAZARDOUS ENVIRONMENTS, NOT OTHERWISE CONTROLLABLE. THEY ARE RELATIVELY SIMPLE IN DESIGN. THEY NEED A GOOD AIR SUPPLY.

WHEN BLOWERS ARE EMPLOYED WITH SUCH RESPIRATORS IT IS NECESSARY TO HAVE AN INDIVIDUAL ATTENDING THE BLOWER OR A STAND-BY. AN EXAMPLE OF THE VALUABLE APPLICATION OF THE HOSE AIR-SUPPLY RESPIRATORS IS IN THE OCCUPATION OF SANDBLASTING.

SUCH RESPIRATORS PRODUCE AN INCREASED RESISTANCE TO BREATHING. THEY FREQUENTLY HAVE A LONG HOSE ATTACHED WHICH, IN AND OF ITSELF, MAY BE A NUISANCE OR A SAFETY HAZARD. THERE ARE LIMITATIONS ON THE MAXIMUM LENGTH OF HOSE THAT CAN BE USED WITH THE AIR-SUPPLIED RESPIRATORS. IF THE RESPIRATOR IS ONE THAT IS GOING TO BE USED WITHOUT A BLOWER, THEN THE TUBE COMING FROM THE AIR SUPPLY SHOULD BE LESS THAN 50 FEET IN LENGTH. IF IT IS TO BE USED WITH BLOWERS, THE TUBE LENGTH MAY BE ANYWHERE FROM

150 TO 200 FEET. SUCH TYPES OF RESPIRATORS ARE USED WHEN ONE WISHES TO ENTER A CLOSED ENVIRONMENT SUCH AS TANKS, TUNNELS, PITS WHERE DUST VAPORS AND GASES MAY BE PRESENT.

THE AIR LINE LEADING TO THE FACE PIECE IS ATTACHED TO A COMPRESSED AIR SOURCE, EITHER A COMPRESSOR OR A GAS CYLINDER. THE CYLINDERS ARE UNDER HIGH PRESSURE THEREFORE PRESSURE REGULATORS, RELIEF VALVES, AND THE MANNED-TYPE OF REGULATORS ARE NEEDED.

MANY OF THE AIR-SUPPLIED RESPIRATORS EMPLOY A SLIGHT POSITIVE PRESSURE IN ORDER TO PREVENT INWARD LEAKS AT THE FACE PIECE. THEY ARE GOOD FOR HAZARDOUS ENVIRONMENTS NOT IMMEDIATELY DANGEROUS TO LIFE. EXAMPLES, SPRAY PAINTING AND WELDING. THEY CAN BE USED CONTINUOUSLY, BUT ONE MUST BE SURE THAT THE AIR WHICH IT IS BEING PROVIDED IS FREE OF CARBON MONOXIDE AND CARBON DIOXIDE. FOR EXAMPLE, I HAD A SITUATION NOT TOO LONG AGO WHERE I HAD A TANK OF COMPRESSED AIR DELIVERED TO ME. PRIOR TO USING THIS FOR HUMAN BREATHING PURPOSES, I ANALYZED THE AIR AND FOUND THAT IT CONTAINED 35% CARBON DIOXIDE. IN TRACING THE SOURCE OF THE SUPPLY OF AIR, IT WAS FOUND THAT THE COMPRESSOR WAS DRAWING AIR FROM AN AREA ABOVE AN INCINERATOR THAT WAS IN OPERATION.

OTHER FACTORS BESIDE THE HOSE SIZE AND HOSE WEIGHT TO BE CONSIDERED WITH AIR-SUPPLIED MASKS ARE TEMPERATURE AND HUMIDITY.

THE LAST GROUP OF RESPIRATORS IS THE SELF-CONTAINED TYPE. THESE PROVIDE COMPLETE RESPIRATORY PROTECTION FOR ANY CONCENTRATION OF TOXIC GAS OR OXYGEN DEFICIENCY. THEY CAN BE USED WITH AN AIR SOURCE OR AN OXYGEN SOURCE. THEY ARE USUALLY EMPLOYED IN EMERGENCY SITUATIONS. THE SELF-CONTAINED APPARATUS IS HEAVY, BULKY, REQUIRES HIGHLY TRAINED INDIVIDUALS FOR USE. IT CAN BE OF A DEMAND OR A REBREATHING TYPE.

IN THE PRESSURE DEMAND TYPE, THE SLIGHT NEGATIVE PRESSURE INITIATED BY THE INDIVIDUAL AT THE BEGINNING OF INSPIRATION TRIGGERS THE VALVE SO THAT THE GAS WILL FLOW AS IT IS NEEDED AT AN APPROPRIATE FLOW RATE. SUCH PRESSURE DEMAND SYSTEMS MUST BE FLOW SENSITIVE AS WELL AS PRESSURE SENSITIVE AND ALLOW THE INDIVIDUAL TO BREATH IN THE GAS AT WHATEVER MAXIMUM FLOW HE DESIRES. THESE ARE NON-REBREATHING SYSTEMS AND THEREFORE DISCHARGE THE AIR AWAY FROM THE MASK OR FROM THE INDIVIDUAL. IT IS NECESSARY WHEN ONE EMPLOYS SELF-CONTAINED RESPIRATORS TO HAVE WARNING DEVICES INDICATING THAT THE PRESSURE SUPPLY IS GETTING LOW.

WELL SO MUCH FOR THE TYPES OF EQUIPMENT. LET US LOOK NOW AT SOME OF THE OTHER PROBLEMS ASSOCIATED WITH RESPIRATOR USE.

THE FIRST THAT COMES TO MIND IS THAT OF SAFETY--THE FIT AND IMPROPER SEALING OF THE MASK. IF A LEAK OCCURS AT THE MASK, ESPECIALLY AN INWARD LEAK, THE TOXIC MATERIALS MAY BE INHALED AND A FALSE SECURITY WILL BE PROVIDED. AS MENTIONED PREVIOUSLY, THERE IS A MARKED VARIABILITY IN THE CONTOUR OF FACES. IT IS VERY IMPORTANT THAT ANY MASK FIT COMFORTABLY, OTHERWISE AN INDIVIDUAL USING IT OVER A LONG PERIOD OF TIME MAY FIND A MASK TO BE INTOLERABLE.

WHEN EFFORT IS EXPENDED AND WORK IS PERFORMED REQUIRING INCREASED OXYGEN DEMAND, PERSPIRATION IS NOT ADEQUATELY EVAPORATED; IT REMAINS WITHIN THE MASK PRODUCING AN UNPLEASANT EFFECT. TOXIC SUBSTANCES MAY BECOME TRAPPED BETWEEN THE SKIN AND THE MASK CAUSING LOCAL IRRITATION. I AM REMINDED OF A SITUATION IN THE UNITED STATES AIR FORCE WHERE WE WERE ASKED TO INVESTIGATE A SERIES OF REACTIONS OCCURING TO PILOTS IN A PARTICULAR TYPE OF PLANE. THESE REACTIONS WERE THOUGHT TO BE DUE TO CARBON MONOXIDE, HOWEVER, IT TURNED OUT THAT THE IRRITATION, UNPLEASANT ODOR AND GASTRIC REACTION

WERE DUE TO MERCAPTANS FOUND WITHIN THE TUBING. RELATED TO THIS IS THE OBSERVATION THAT ALLERGIC REACTION TO THE MATERIALS HAS BEEN KNOWN TO OCCUR.

PSYCHOLOGICAL PROBLEMS ASSOCIATED WITH THE USE OF RESPIRATORS HAVE BEEN OBSERVED. MANY PEOPLE FIND THE CONFINEMENT AND SENSE OF ISOLATION DISTRESSING; OTHERS ARE UNEASY ABOUT THE NEED TO WORK IN AN ENVIRONMENT THAT REQUIRES THE USE OF SUCH EQUIPMENT.

ANOTHER PROBLEM ASSOCIATED WITH THE USE OF RESPIRATORS AND MASKS IS DEAD SPACE. IT IS VERY IMPORTANT THAT THE INDIVIDUAL NOT REBREATHE EXHALED AIR AND THAT THE DEAD SPACE IN THE MASK BE KEPT TO LESS THAN 150 CC OR THAT THE THE MASK BE ADEQUATELY VENTILATED TO FLUSH OUT THE DEAD SPACE. OTHERWISE THERE WOULD BE REBREATHING OF EXHALED CARBON DIOXIDE AND A DEFICIENCY IN INSPIRED OXYGEN.

THE EYEPIECE ON FULL-FACE MASKS IS OF IMPORTANCE. THESE MUST BE LEAK PROOF. THEY SHOULD NOT DISTORT THE VISION. THEY DO DECREASE THE FIELD OF VISION. IF AN INDIVIDUAL WEARS GLASSES, THE GLASSES CAN BECOME FOGGED OR THE FACE EYEPIECE ITSELF MAY BECOME FOGGED. THE INDIVIDUAL WITH BIFOCAL VISION MAY HAVE DIFFICULTY LOOKING THROUGH THE EYEPIECE AND PERFORMING HIS TASK. IT MAY BE NECESSARY TO CONSTRUCT THE EYEPIECES BY MEANS

OF SPECIAL GRINDING WITH BUILT-IN CORRECTIVE SPECTACLES FOR AN INDIVIDUAL. ANTI-FOGGING COMPOUNDS MAY HAVE TO BE EMPLOYED TO PREVENT FOGGING, OR IT MAY BE NECESSARY TO WEAR A NOSE CLIP TO PREVENT FOGGING OF THE EYEPIECE. ALL OF THESE CAN DECREASE EFFICIENCY AND BE UNCOMFORTABLE AND UNPLEASANT FOR THE INDIVIDUAL WHICH IN TURN MAKES THE WEARING OF THE MASK A DIFFICULT TASK.

ANOTHER PROBLEM ASSOCIATED WITH MASKS IS SPEECH TRANSMISSION. UPON MOVEMENT OF THE JAWS, THE MASK MAY BECOME DISTORTED AND LEAKS OCCUR. IT MAY BE NECESSARY TO EQUIP THE MASKS WITH SPECIAL DIAPHRAGMS, MICROPHONES, AMPLIFIERS, AND RADIOS IN ORDER TO PROVIDE ABILITY FOR COMMUNICATION.

A VERY IMPORTANT CONSIDERATION IN THE WEARING OF RESPIRATORS PERTAINS TO PERSONS WHO ARE FOUND TO BE SUFFERING FROM BRONCHITIS, EMPHYSEMA, OR CHRONIC ASTHMA. SUCH PEOPLE SHOULD NOT BE EMPLOYED IN WORK ENTAILING THE USE OF A RESPIRATOR. THIS LIMITATION KNOCKS OUT A LARGE SEGMENT OF OUR WORKING POPULATION. SURVEYS HAVE DEMONSTRATED THAT THE INCIDENCE OF CHRONIC OBSTRUCTIVE PULMONARY DISEASE IN MALES OVER THE AGE OF 35 RUNS APPROXIMATELY 32%; AND THERE IS VERY LITTLE DIFFERENCE IN FEMALES. IF ONE LOOKS AT THE ENTIRE POPULATION,

INCLUDING CHILDREN, AND THE ENTIRE SPECTRUM OF AGE, THE INCIDENCE OF CHRONIC OBSTRUCTIVE LUNG DISEASE MAY RUN AS HIGH AS 3%. PATIENTS WITH CHRONIC OBSTRUCTIVE LUNG DISEASE WOULD FIND THE RESISTANCE AND THE OTHER FACTORS ASSOCIATED WITH THE WEARING OF MASKS TO BE UNPLEASANT AND CAUSE FURTHER DIFFICULTY IN THEIR BREATHING.

RESPIRATOR TRAINING PROGRAMS ARE NEEDED WHERE THE INDIVIDUAL WHO IS TO WEAR THE MASK CAN BE PROPERLY INSTRUCTED IN ITS USE, ITS WORKINGS, AND ITS CARE. RESPIRATOR MAINTENANCE PROGRAMS MUST BE DEVELOPED WHEN MASKS ARE USED. THESE MASKS SHOULD BE INSPECTED MONTHLY. THEY HAVE TO BE CLEANED AND EXAMINED AFTER EACH USE. IF THEY ARE GOING TO BE USED BY MORE-THAN ONE INDIVIDUAL, THEY HAVE TO BE CLEANED AND CARED FOR DAILY. THEY MUST BE WASHED IN SOAP AND WATER OR WITH DETERGENT AND ALLOWED TO AIR DRY OR BE DRIED BY FORCED AIR. OCCASIONALLY IT MAY BE NECESSARY TO STERILIZE THE MASK, BECAUSE IT MAY BECOME A SOURCE FOR BACTERIAL CONTAMINATION AND DISEASE TRANSMISSION. CLEANING AND REPAIR STATIONS HAVE TO BE SET UP WHERE MASKS OR RESPIRATORS ARE BEING USED.

STORAGE IS ANOTHER FACTOR THAT MUST BE CONSIDERED. PROPER FACILITIES MUST BE PROVIDED TO KEEP THE RESPIRATORS AND THEIR COMPONENT PARTS IN GOOD CONDITION.

IN SUMMARY, PREVENTION IS THE MAIN DEFENSE IN OCCUPATIONS THAT POSE RESPIRATORY HAZARDS. IT IS BEST TO ELIMINATE CONTAMINANTS AT THE SOURCE OR TO DECREASE THE CONCENTRATION OF THE CONTAMINANTS TO AN ACCEPTABLE, ALLOWABLE LIMIT. WHERE SUCH CANNOT BE ACCOMPLISHED, PROTECTIVE EQUIPMENT SHOULD BE CONSIDERED.

RESPIRATORS, IF USED, SHOULD BE SELECTED CAREFULLY FOR THE SPECIFIC HAZARD. HOWEVER, IT MUST BE RECOGNIZED THAT THEY HAVE UNDESIRABLE FEATURES AND HAZARDS, THE MAJOR OF WHICH ARE INCREASED RESISTANCE TO BREATHING, DECREASED EFFICIENCY OF FUNCTION, POOR FIT, LEAKAGE, FALSE SECURITY, ALLERGIC REACTIONS, IRRITATION FROM PERSPIRATION AND OTHER PARTICULATE DEPOSITIONS, REBREATHING, HEADSPACE VENTILATION, POOR VISION, FOGGING OF THE EYEPIECES, SPEECH, PSYCHOLOGICAL AND CONTAMINATION PROBLEMS. THEY REQUIRE SPECIAL CARE, TRAINING, MAINTENANCE, STORAGE. FINALLY, A LARGE SEGMENT OF THE POPULATION, MANY ALREADY WORKING WITHIN INDUSTRY, HAVE CHRONIC OBSTRUCTIVE PULMONARY DISEASES SUCH AS BRONCHITIS AND EMPHYSEMA AND SHOULD NOT BE EMPLOYED IN A WORK ENVIRONMENT WHICH REQUIRES THE CONTINUED OR FREQUENT USE OF RESPIRATORS.

IN CONCLUSION, AND ADDRESSING MYSELF TO THE SPECIFIC PROBLEM PRESENTED HERE, IT IS MY PROFESSIONAL OPINION THAT THE USE OF RESPIRATORS FOR FULL-TIME PROTECTION IN VINYL CHLORIDE AND POLYVINYL CHLORIDE PRODUCTION FACILITIES IS UNSAFE AND INFEASIBLE. FURTHERMORE, WITH PROPER ASSURANCE OF SATISFACTORY FIT AND THE MAINTENANCE OF ADEQUATE RESERVE CAPACITY IN THE CANISTER, IT IS MY OPINION THAT CANISTER-TYPE MASKS WILL PROVIDE PROTECTION TO WORKERS IN THESE INDUSTRIES WHEN WORN FOR LIMITED PERIODS OF TIME IN ATMOSPHERES WHERE THE CONCENTRATION OF VINYL CHLORIDE IS NOT EXCESSIVE.

associated with respirator use.

The first that comes to mind that of safety, the fit and improper sealing of the mask. If a leak occurs at the mask -- especially an inward leak -- the toxic materials may be inhaled and a false security be provided. As mentioned previously, there is marked variability in the contour of faces. It is very important that any mask fit comfortably. Otherwise, an individual using it over a long period of time may find a mask to be intolerable.

When effort is expended and work is performed requiring increased oxygen demand, perspiration is not adequately evaporated; it remains within the mask producing an unpleasant effect. Toxic substances may become trapped between the skin and the face causing local irritation or absorption. I am reminded of a situation in the United States Air Force where we were asked to investigate a series of reactions occurring to pilots in a particular type of plane. These reactions were thought to be due to carbon monoxide. However, it turned out that the irritation, unpleasant odor, and gastric reaction they were experiencing was due to mercaptans found within the tubing. Related to this is the observation that allergic or sensitivity reactions to materials have been known to occur.

Psychological problems associated with the use of respirators have been observed. Many people find the confinement and sense of isolation distressing; others are uneasy

about the need to work in an environment that requires the use of such equipment.

Another problem associated with the use of respirators and masks is dead space. It is very important that the individual not rebreathe exhaled air and that the dead space in the mask be kept at less than 150 cc or that the mask be adequately ventilated to flush out the dead space. Otherwise, there would be rebreathing of exhaled carbon dioxide and a deficiency in inspired oxygen.

The eyepiece on the full-face masks is of importance. These must be leakproof. They should not distort the vision. They do decrease the field of vision. In an individual wearing glasses, the glasses can become fogged or the face eyepiece itself may become fogged. The individual with bifocal vision may have difficulty looking through the eyepiece and performing his tasks. It may be necessary to construct the eyepiece by means of special grinding with built-in corrective lenses for an individual. Antifogging compounds may have to be employed to prevent fogging, or it may be necessary to vent a hose valve to prevent fogging of the eyepieces or the glasses. All of these can decrease efficiency and be uncomfortable and unpleasant to the individual, which, in turn, makes the wearing of the mask a difficult task.

Another problem associated with masks is speech transmission. Upon movement of the jaw, the mask may become

distorted and leaks occur. It may be necessary to equip the masks with special diaphragms, microphones, amplifiers, and radios in order to provide ability to communicate.

A very important consideration in the wear of respirators pertains to persons who are found to be suffering from bronchitis, emphysema, and chronic asthma. Such people should not be employed in work entailing the use of a respirator. This limitation knocks out a large segment of our working population.

Surveys have demonstrated that the incidence of chronic obstructive pulmonary disease in males over the age of 35 runs approximately 32 percent. Dr. Selikoff yesterday gave us a figure in the vinyl industry in some of the older men -- or the older men working the industry to be in the range of 58 percent. That is significantly above what we found in our surveys.

And there appears to be -- in our surveys there was very little difference in the incidence of chronic obstructive lung disease in females. We ran around 28 to 30 percent.

If one looks at the entire population, including children, and the entire spectrum of age, the incidence of chronic obstructive lung disease may run as high as 3 percent. Patients with chronic obstructive lung disease would find the resistance and the other factors associated with the wearing of the masks to be unbearable and would have the difficulty in their

breathing. In the first place, they shouldn't be in an environment that is contaminated and, secondly, they should not be asked to wear respirators.

Respirator training programs are needed where the individual who is to wear the mask can be properly instructed in its use, its workings, and its care. Respirator maintenance programs must be developed when masks are used. These masks should be inspected monthly. They have to be cleaned and examined after each use. If they are going to be used by more than one individual, they have to be cleaned and cared for daily. They must be washed in soap and water or with detergent and allowed to air dry or be dried by forced air. Occasionally it may be necessary to sterilize the mask because it may become contaminated or it may become a source of bacterial contamination and disease transmission. Cleaning and repair stations have to be set up where masks or respirators are being used.

Storage is another factor that must be considered. Proper facilities must be provided to keep the respirators and their component parts in good condition.

In summary, prevention is the main defense in operations that pose respirator hazards. It is best to eliminate contaminants at the source or to decrease the concentration of the contaminants to an acceptable, allowable, safe limit. Where such cannot be accomplished, protective equipment should be considered.

Respirators, is used, should be selected carefully for the specific hazard. However, it must be recognized that they have undesirable features and hazards, the major of which are increased resistance to breathing, decreased efficiency or function, poor fit, leakage, false security, allergic reactions irritation from perspiration, and other particulate deposition, rebreathing, deadspace ventilation, poor vision, fogging of the eyepieces, speech, psychological, and contamination problems. They require special care, training, maintenance, and storage.

Finally, a large segment of the population, many already working within the industry, have chronic obstructive pulmonary disease such as bronchitis and emphysema and should not be employed in a work environment which requires the continued or frequent use of respirators.

In conclusion, and addressing myself to the specific problem presented here, it is my professional opinion that the use of respirators for full-time protection in vinyl chloride or polyvinyl chloride production facilities is unsafe and indefensible. Furthermore, with proper attention to satisfactory fit and the maintenance of adequate reserve capacity in the canister, it's my opinion that canister-type masks will provide protection to workers in these industries what were for limited periods of time in atmospheres where the concentration of vinyl chloride is not excessive, and I think it requires some definition of what "not excessive" is.

which this can be accomplished, that it is preferable. If, however, it cannot be accomplished, then a respirator can be used.

The type of respirator depends upon the situation. I mentioned here in my conclusion that a canister-type can be used safely for short periods of time when the concentration is not excessive.

I think he mentioned that in certain circumstances it might be necessary to wear an air line or a air hose-supplied type of a mask.

MR. WEBB: Are you aware of any specific canisters that are on the market today that would be effective as a respirator for lead chloride?

DR. ZAPOROWSKI: No, I am not. However, I've been informed that such are in the process of being developed and perhaps there are others who might know that there is such in existence, but I do not know of any.

MR. WEBB: Dr. Brandon would like to ask a few questions.

DR. BRANDON: Just as a point of departure with your Air Force experience, isn't it normal in the Air Force that some crews will wear respiratory protective devices for, say, extended periods of greater than four to eight hours during operations?

DR. ZAPOROWSKI: Yes, this is quite true. Many times

a man is on oxygen continuously during high performance-type aircraft in high altitude flights.

DR. LACHTER: Do you consider that most of the problems inherent with the type of respiratory protective devices that you mentioned today are primarily because these types of devices are designed for short-term effects such as you mentioned and that you consider it might be feasible that aside from the individual respiratory problems that you mentioned with some few individuals, that a respirator protective device designed for a longer term period, say, four to eight hours, could be designed or could be developed?

[illegible]: In part that is true. But I think it is unfair to look back at Air Force experience and say Air Force personnel wearing a mask for a period for six or eight hours. They are breathing it for a primary purpose and that purpose is for adequate oxygen delivery. They are not breathing it for the removal of particulates or removal of contaminants which [illegible] atmosphere, so it's for an entirely different purpose.

There we talk about contaminants and other pollutants then those factors that I mentioned come into consideration.

DR. LACHTER: Getting back -- I just mention this as a design, to show that some individuals do do this, not saying that perhaps the industrial situation will be apropos for the same type of respiratory protective device. What I wanted

DR. TOMASZEWSKI: Prolonged breaks?

MR. SAMUELS: Yes.

DR. TOMASZEWSKI: Intermittent usage?

MR. SAMUELS: Yes.

DR. TOMASZEWSKI: I don't that would be a very desirable approach.

MR. SAMUELS: Are you aware of the industrial practice of asking workers to wear their workers' dirty respirator from the prior day?

DR. TOMASZEWSKI: Yes, this is common practice and there are many other aspects of respirators that I don't want to take time to explain.

MR. SAMUELS: Is it your opinion that this practice were prohibited by law that the responsibility of respirators to workers might increase?

DR. TOMASZEWSKI: I have doubts, and I say this on the basis of talking to patients who were required to wear respirators.

When I go back over the coal mining experience that I've had and the many coal miners that I've seen, I find where respirators were recommended to them, they wouldn't wear them because, again, of resistance to breathing and inefficiency of performing their tasks. They'd tear them off and they wouldn't wear them.

The same thing was true in the foundry industry where

we take histories from men there who were advised to wear respirators. They would admit to the fact that yes, they'd wear them off and on or they'd take them off and let them dangle along their face.

But in the hospital when we make our rounds on patients on whom we have ordered oxygen administration by mask, we find that when we're going around they take those masks off. Here's a life-saving, sustaining situation. They take it off and let it dangle on you and it hanging at the side of the bed with the oxygen being delivered to the room.

So to try to get people to accept respirators and breathing any area of the factory that I mentioned is going to be an extremely difficult task. It will probably require some very stringent legislation to try to do it. I don't see how it can be enforced, really.

MR. SHUBERT: Of the employee workers to whom you've referred -- I think you said foundry and coal miners -- you have not conducted a program in the mine or at the mine site or at the plant or at the plant site or in the union hall on the education of workers relative to respirators?

DR. ZUCKERMAN: I have not. The only program we've conducted was with our employees at Battelle.

MR. SHUBERT: Thank you.

JUDGE WAIT: Are there any other questions?

Yes, sir.

JUDGE MYAIT: Proceed, gentlemen.

MR. KLEIN: Excuse me, Your Honor. I would request that you ask the witnesses for an extra copy for us.

THE SOCIETY OF THE PLASTICS INDUSTRY, INC.

RALPH L. HARDING, JR.

[MR. HARDING: Judge Hyatt, my name is Ralph L. Harding, Jr. I am president and chief staff officer of the Society of the Plastics Industry, Incorporated, New]

After a few brief remarks to complete the record regarding SPI, I will be introducing the next several witnesses who are appearing today on behalf of the vinyl chloride and polyvinyl chloride producers' committee, a operating unit of SPI.

SPI is the industry association for the plastics industry. Our 1,400 members and 51 operating units include producers of the plastics raw materials or resins and of the various modifiers and adjuvants used, the plastics machinery and mold builders, and, of course, the processors or converters of the resins into finished components or products. We estimate that our membership represents over 95 percent of the plastics materials and machinery produced in the United States and about 75 percent of the processing volume.

In 1973 total plastics production was 27 billion pounds. The four principal plastics were: polyethylene, 8.4 billion pounds; polyvinyl chloride and other vinyls, 5.4 billion

strong personal stake in the medical facts and in the safeguards, to say the least. Nobody has to remind them of their responsibilities to their fellow workers.

Before proceeding to our witnesses, I need to report on one other matter. On June 7 I participated in a meeting in Paris of the heads of staff of plastics associations from 18 countries around the world. Topic number one was VCM.

Please keep in mind that in most European countries, except England, and in Japan VCM is consumed on a higher per capita basis than in the United States. I learned that in other countries, without exception, there was close cooperation between the VCM producers and their governments and that the government officials assumed a responsible role in both the problems and the ramifications. Both my colleagues and their governments have been following events in the United States as reported in the press with great interest and concern.

My colleagues advised me that their government officials did indeed understand that VCM could present a potential health hazard which must be overcome. However, I was told that the other governments appear to believe that VCM can be dealt with rationally and properly. Of greatest concern to them is what the American Government will do.

In the hope that it might clear up some misconceptions arising from rather sketchy reports on the European and particularly the United Kingdom's activities in this area, I would ask

that a copy of a June 17 letter sent to us by Mr. A. W. Barnes, Director of the Plastics Division of Imperial Chemical Industries, Ltd., be included in the record along with a copy of a press release issued by the British Department of Employment on June 12 or 13 -- this is attached to my statement.

I think it will be clear to anyone who reviews this documentation that the position of the European industry is essentially the same on this item, that is, every effort is being made to obtain a flexible, with the British believing that a 50 page, one million cubic centimeter load can be achieved in this area, but that improvements to reach lower levels will require a considerable expenditure of time and money which cannot be justified.

Now I would like to call on Herman Hochman, General Counsel of S.P.I. to inform you of the points to be covered by our panel of experts and to indicate areas of great concern relative to specific provisions in the proposed permanent standard.

MR. McGRATH: Thank you, Ralph.

THE SOCIETY OF THE PLASTICS INDUSTRY, INC.

JEROME H. HOCHMAN

MR. HOCHMAN: Judge Kyath, my name is Jerome H. Hochman. I am a partner in the Washington law firm of Keller and Heckman and have served as counsel for the Society of the Plastics Industry for the past twenty years.

Attachment 1, Exhibit 20B

Hertfordshire England

Telephone Welwyn Garden 23400 (STD Code 07073)
STD Code from London Area 96
Telex 7

ICI Fibres
Industries
Limited

543

Plastics
Division

Mr R Harding
Society of Plastics Industry
250 Park Avenue
New York
New York 10017
USA

copy for: Mr Jerome H Heckman
of Keller & Heckman, USA

Your ref	Our ref	Tel ext	Date
	AWB/MKH	3012	17 June 1974

Dear Ralph

As you know, the UK Chemical Industries Association held a Press Conference on the 16 May to bring the British Press up-to-date with the problems of vinyl chloride toxicity. An aide-memoire was issued to the Press after the meeting, and a copy is attached for convenient reference.

I understand from David Dowrick who was present at a meeting of the Society of Plastics Industry in Washington earlier this month that there was some confusion about the targets described for vinyl chloride concentrations in the atmosphere of UK polymer plants. The relevant paragraph in the aide memoire is the one starting at the bottom of page 4, which gives a historical view of the average concentrations in polymerisation plants and then indicates the technical targets for the future. We are anxious to clear up any misunderstanding and to do this I think that it would be worth emphasising one or two points in the paragraph, as was done at the Press Conference itself.

First, the figures relate to the average concentrations which would be found in the main working areas of the plant around the polymerisation process, ie. the autoclaves. Second, the figure of 10 ppm vinyl chloride for the ultimate average background level on existing UK plants is for us a target figure, which we might hope (but cannot guarantee) to achieve after much money has been spent and modifications made. Third, the figure of 5 ppm vinyl chloride is the average level which new plants with modern technology might achieve. As I mention above, these matters were dealt with more fully at the Press Conference and you might find it helpful to refer to the transcript of the appropriate section of the Conference, which is also attached.

I hope that these comments will clarify the position. You may also like to know that a meeting of Government Departments, Unions and the CIA was held at the end of last week to discuss the VCM problem. I think it probable that a Press release will be issued shortly outlining the content of the meeting and as soon as this is available I will let you have a copy.

Kind regards

Yours sincerely

"Those improvements have basically been made by modification to process procedures, and some modification to plant where that was easy to do.

We intend to go on, but the next stage will come mainly from detailed plant modification. This is a massive operation. Having been told what sort of material we are handling, you can see that at every pipe joint, every valve, every stirrer gland and so on there is a possibility of some very slight leakage, and we have to modify all those things in order to reduce this very slow, very slight leakage, which can produce levels at the moment of about 50 ppm.

Our belief as an industry is that with the existing plant it is highly unlikely that, however much money we spent and whatever we did, we would ever get below about 10 ppm. It is just possible that with entirely new plants making some of the existing polymers we might be able to get into the 5 ppm region."

Ex 200

Statement of Anton Vittone
President, B.F.Goodrich Chemical Company
Prepared For
Presentation At
Department of Labor Hearings On
Vinyl Chloride, Occupational Exposure Standard
June 25, 1974

My name is Anton Vittone. I am President of B.F.Goodrich Chemical Company, a Division of The B.F.Goodrich Company. Our headquarters are at 6100 Oak Tree Boulevard, Cleveland, Ohio. I graduated in Chemical Engineering with a Masters Degree in 1939 from the University of Washington at Seattle. For the past 32 years I have been employed by The B.F.Goodrich Company. Most of my experience with Goodrich has been in the fields of manufacturing, development, and engineering having started as a shift foreman in manufacturing. Since April 16, 1974 I have served as chairman of the Society of The Plastics Industry's Committee of Vinyl Chloride Monomer and Polyvinyl Chloride Producers. Members of this Committee represent over 90 percent of the current United States capacity for the production of vinyl chloride and polyvinyl chloride resin.

I have prepared a statement in behalf of SPI and the Committee which I will read and submit for the record of this hearing. More detailed testimony concerning certain aspects of my testimony will be presented by others in behalf of SPI. My statement represents the views of the majority of the Committee, however, different positions will be expressed on certain sections of the proposed permanent standard by industry members in the course of this proceeding. The Committee is unanimous in its position that the proposed permanent standard is not technologically feasible and, if adopted, would shut down the industry.

The PVC and vinyl monomer producers are aware of the experimental work of Professor Maltoni and Industrial Bio-test Laboratories in which angiosarcoma of the liver has been reported in both rats and mice at long-term exposure levels as low as 50 ppm. We are also aware of the fact that in recent work reported by Professor Maltoni the angiosarcoma which developed in rats following long-term exposure at 50 ppm occurred at the end of their normal life span.

Dr. Marcus Key of NIOSH, in his letter to the Department of Labor on March 11, 1974, made the following comment and I quote -- "Based on theoretical considerations there is probably no threshhold for carcinogenesis although it is possible that with very low concentrations the latency period might be extended beyond the life expectancy" -- end of quote.

The recent results of Professor Maltoni of rats exposed to 50 ppm indicates that the latency period was approaching the life span of rats which we understand is equivalent to an 80 year human life span.

In turn, we all must be aware of the inherent uncertainties of extrapolating from animals to humans and also from high level of exposures that existed in our plants in earlier years to those that exist today.

The exposure of workers to vinyl chloride has varied with the age of the industry. In the 1940's the degree of exposure of workers to vinyl chloride

was no doubt greater than in the 1950's and, in turn, the 1950's versus the 1960's, etc.

Unfortunately records are not available on the precise level of exposure with respect to periods of the industry's history. In order to get some estimate of exposure levels in history we must depend on the recollections of employees as to levels of odor and work practices and to reconstruct today, conditions considered to exist 30 and 20 and 10 years ago. To the extent that this has been done, we believe that the average exposure in the decade of the forties could have been [redacted] some forty times greater than they are today. With respect to peak exposures they no doubt were some 100 times of today's emergency standard of 50 ppm since employees were known to have become mildly intoxicated from exposure to vinyl chloride.

On the basis of this background of information, it is only prudent that we continue to decrease the level of exposure of our workers. While it can be argued that there is no safe level of exposure, the basis of the proposed standard, it can similarly be argued that there is no data showing that exposure levels as provided for under the emergency standard are not safe or of low degree of risk. The current levels of exposures, when considered in the light of past exposures especially in the decades of the 40's and the 50's, certainly must be considered in judging the degree of risk of a standard above the no-detectable level. It is simple to

assume zero exposure and, therefore, zero risk. The only practical way of accomplishing this is to shut down the PVC industry or to impose work practices which will create a greater immediate risk to health and safety than exposure to low levels of vinyl chloride.

It is the position of the industry, which I will detail later, that it will commit itself to lowering exposure of its workers by a combination of lower levels of vinyl chloride in the work atmosphere and work practices. Such a commitment cannot be accomplished overnight since, in certain areas, the technology for accomplishing it is, as yet, not developed and, when developed, facilities must be installed requiring time for engineering, procurement, and installation.

We fully recognize that there are those who will say that the industry can do better than it says and, therefore, tighter restrictions should be imposed than proposed by the industry. It should be recognized that the proposal which I will make later has already taken into consideration projections for improvement which are not in hand but depend on new developments and additions to facilities.

Polyvinyl chloride represents a large industry which, in 1973, had an estimated world-wide output of 18 billion pounds and a United States output of 4.6 billion pounds.

The initial impetus for the growth of PVC in the United States came from the requirements of national defense in World War II. The fire resistant properties of PVC made it a superior insulation for electrical wiring for naval vessels and other military applications. It provided a degree of protection against fire that had not previously existed. There is no doubt that these PVC uses helped save many lives during the War and, since then, in similar military and commercial applications. Following the War, many new uses were found for PVC because of its versatility and inherent performance qualities. Today, it is used in hundreds of PVC products and also in the production of essential components for many other assembled products. Hundreds of thousands of workers are employed in industries that produce or depend on PVC for the manufacture of countless products.

The production of vinyl chloride, its polymerization into PVC resin, and the processing of PVC resin into semi-finished or finished products is treated in the proposed permanent standard as one industrial health problem. However, each is an entirely different manufacturing operation posing its own problems, permitting and requiring different solutions. Of the hundreds of thousands of workers whose jobs are dependent on PVC only 6,500 are involved in the manufacture of vinyl chloride and polyvinyl chloride resins.

Furthermore, that segment that involves the production of polyvinyl chloride is not a monolithic operation. Several different processes are utilized

with may process variations and with a wide variety of polyvinyl chloride resin products. Current installations are extremely varied and do not lend themselves to the simple solution of a restricted area where employees would only work for a brief part of the work day and, thus, be able to utilize self-contained breathing apparatus as provided for in the proposed permanent standard. The imposition of the no-detectable level as provided for in the proposed permanent standard would require the full-time utilization of self-contained breathing apparatus during the work period in vinyl chloride and PVC resin producing facilities. This would impose a severe and unnecessary physical burden on our workers as well as a potential health and safety problem. Further, because of space limitations, it is impossible to use self-contained breathing apparatus in cleaning reactors.

Historically, the greatest exposure of workers to vinyl chloride has occurred in the polyvinyl chloride production segment of the industry.

Currently the level of exposure is lower in the vinyl chloride production segment of the industry. Nevertheless, the imposition of a no-detectable level standard for this segment of the industry, as proposed, would, as in the case of the PVC resin plants, require the full-time utilization of self-contained breathing apparatus with the problems and potential hazards I have already mentioned.

The third segment of the industry is that of processing and fabrication where the level of exposure is the lowest. Available data indicate that worker exposure in most work areas is at no-detectable levels as defined by the proposed standard.

The areas of potential exposure are those involving bulk unloading, storage, and mixing areas. Even in these areas it appears that level of worker exposure can be reduced to low levels by known engineering solutions. In addition, the reduction of residual vinyl chloride monomer in the PVC resin by the PVC resin producer will further lower the potential of worker exposure.

Since the problems of worker exposure in processing and fabricating plants are limited and engineering solutions are available, this segment of the industry should not be subjected to the full coverage of the proposed permanent standard.

With respect to PVC resin and vinyl chloride, the producers have stated that a no-detectable level for vinyl chloride, as defined, would shut the industry down.

As stated earlier, it is not feasible to require workers to continuously use self-contained breathing apparatus.

Therefore, there are only two ways to seek a no-detectable level: To eliminate all losses of vinyl chloride or to dilute losses through ventilation.

Neither of these alternatives is feasible, in our judgment, because losses from processing equipment will always occur. Some are identifiable and others are fugitive losses.

The fugitive losses are those losses which occur from mechanical equipment, such as valves, pumps, flanges or fittings, column manheads, reactor manheads, etc. and impossible to quantify. All plants have hundreds of valves, pumps, flanges, etc. all of which are a potential source of a small leak and which must receive constant attention. This is especially true in older plants with small reactors. The industry has, for years, tried to improve its losses from this source, has made progress and should continue to make progress. Nevertheless, this one type of loss will, in today's plants, provide detectable levels of vinyl chloride in many work areas. This is the primary source of vinyl chloride in the work atmosphere of today's polyvinyl chloride and vinyl chloride plants.

The identifiable losses are those losses which take place from our processes which are inherent in today's plants. While we know of their existence, they are not precisely measured but can be estimated. Technological

improvements requiring time for research and development followed by procurement of equipment and installation can reduce these losses. Any timetable projecting lower levels of exposure is dependent on projection of technological achievement.

The industry has made progress in reducing its losses of vinyl chloride as well as polymer from its processes. I am aware of newer PVC resin plants which have reduced total losses of PVC resin and vinyl chloride to 2%. This compares to an approximate 5% for the industry, in total.

The industry recommends the following standards for polyvinyl chloride resin plants as representing the maximum reduction which a majority of the industry believes feasible:

Effective October 5, 1974, a ceiling of 40 ppm of vinyl chloride and a maximum daily time weighted average of 25 ppm. Levels above 40 ppm would require the use of practical and effective respiratory protection.

Effective October 5, 1975, a ceiling level of 25 ppm with no time weighted average. Levels above 25 ppm would require the use of practical and effective respiratory protection.

Effective October 5, 1976, a ceiling level of 25 ppm with a maximum time weighted average of 10 ppm. Levels above 25 ppm

would require the use of practical and effective respiratory protection.

That sequential monitoring be required of work areas with proper alarms to limit peak exposures to those recommended. The peak exposure levels would be determined by the sequential monitoring system with a built-in 10 minute average sample and/or by a 10 minute grab sample. Instantaneous readings for determining exposure levels are highly unreliable.

The location and number of sampling points would be determined by statistical methods to make certain that the measurements represent the work areas.

The state of the technology today is one where excursions of vinyl chloride in the work atmosphere for one reason or another do occur, although the average level of vinyl chloride in the work atmosphere throughout the day is considerably below the level of such excursions.

The imposition of the 40 ppm ceiling will require the utilization of respiratory equipment for those periods of time when such excursions occur and when corrective action is taken.

The utilization of respiratory equipment for this purpose would not be excessive and, therefore, feasible. The adoption of a 25 ppm time weighted average exposure as of October 5, 1974 would, in practice, result in substantially lower time weighted average exposure for the working population than indicated by the 25 ppm time weighted average since this is a time weighted ceiling.

The adoption of a 25 ppm ceiling as of October 5, 1975 will require industry to make substantial progress in reducing levels of exposure during the one year period. A 25 ppm ceiling will further substantially reduce the time weighted average exposure. Theoretically, it could allow for an occasional 25 ppm time weighted average. However, exposure in such event is highly unlikely and would be rare.

The further imposition of a 10 ppm time weighted average standard on October 5, 1976 would, again, provide assurance of lower levels of exposure for, again, the 10 ppm time weighted average would become a ceiling by this method of measurement and, in practice, would result in substantially lower time weighted average exposure for the working population.

The industry believes it is feasible to operate under more restrictive standards in its vinyl chloride monomer producing operations.

The industry recommends the following standard for levels of exposure in its vinyl chloride monomer producing plants as representing the maximum reduction which a majority of the industry believes feasible:

> Effective October 5, 1974, a ceiling of 25 ppm and a maximum time weighted average of 10 ppm. Levels above 25 ppm would require the utilization of practical and effective respiratory protection.
>
> Effective October 5, 1975, a ceiling of 10 ppm and a maximum time weighted average of 5 ppm. Levels above 10 ppm would require the utilization of practical and effective respiratory protection.

As in the case of the polyvinyl chloride resin plants, the adoption of a time weighted average standard will result in a practical exposure below these ceiling time weighted average values.

It should be recognized that these proposals represent ambitious, difficult levels of operational exposure dependent on large expenditures of money, reduced capacity and the development of technology not currently in hand. Many companies will probably require variances of time or methods, therefore, provision for such variances should be made in the permanent standard.

It should also be recognized that medical and epidemiological data may be developed in the meantime which will require or allow a re-examination of the proposed levels.

We will present testimony later in these hearings as to the feasibility of utilizing canister masks for protection over short periods of time. It is recommended that the utilization of canister masks be permitted when adequate.

The proposed permanent standard calls for the utilization of self-contained respiratory apparatus and an air-supplied impervious suit when cleaning vessels and doing other types of maintenance work. Such a proposal is not feasible, is potentially hazardous, and is unnecessary.

It is recommended that air line supplied respirators be permitted for such operations and, further, that water impervious clothing be used instead of air-supplied suits.

Earlier in this testimony I pointed out that the processing and fabricating segment of the industry currently has a low level of exposure and that problem areas can be solved by engineering methods.

The proposed permanent standard calls for labeling of polyvinyl chloride containing detectable levels of vinyl chloride as to its containing vinyl chloride, a cancer suspect agent absorbed by breathing and through the skin. Such action would essentially require that all polyvinyl chloride be so labeled and is inconsistent with prior standards with carcinogenic chemicals.

In view of the data which has been obtained in fabricating plants, it is recommended that appropriate labeling, as has already been discussed by Mr. Heckman, be required of polyvinyl chloride on October 5, 1974 only when the level of vinyl chloride in the polyvinyl chloride exceeds 0.1 percent.

The industry realizes that it is prudent on its part to reduce levels of vinyl chloride in the polyvinyl chloride resin and, therefore, will attempt in a short period of time to carry out the necessary research and development activities and, assuming success, procure and install the necessary facilities to reduce the vinyl chloride monomer content of polyvinyl chloride.

We believe it difficult, but feasible, by October 5, 1977 to have the major volume of polyvinyl chloride resin produced with less than 100 ppm of vinyl chloride in the polyvinyl chloride. The labeling level could then be dropped to 100 ppm.

be from Mr. Vittone.

MR. HARDING: Judge Myatt, our next speaker is Anton Vittone, Chairman of the SPI Vinyl Chloride and Polyvinyl Chloride Resin Producers' Committee, and he's also President of the B. F. Goodrich Chemical Company.

THE SOCIETY OF THE PLASTICS INDUSTRY, INC. AND B. F. GOODRICH CHEMICAL COMPANY

ANTON VITTONE

MR. VITTONE: My name is Anton Vittone. I am President of B. F. Goodrich Chemical Company, a division of the B. F. Goodrich Company. Our headquarters are at 6100 Oak Tree Boulevard, Cleveland, Ohio.

I graduated in Chemical Engineering with a Master's Degree in 1939 from the University of Washington at Seattle. For the past 32 years I have been employed by the B. F. Goodrich Company. Most of my experience with Goodrich has been in the fields of manufacturing, development, and engineering, having started as a shift foreman in manufacturing.

Since April 16th, 1974, I have served as Chairman of the Society of the Plastics Industry's Committee of Vinyl Chloride Monomer and Polyvinyl Chloride Producers. Members of this committee represent over 90 percent of the current United States capacity for the production of vinyl chloride and polyvinyl chloride resins.

I have prepared a statement in behalf of SPI and the

Committee which I will read and submit for the record of this hearing. More detailed testimony concerning certain aspects of my testimony will be presented by others in behalf of SPI. My statement represents the views of the majority of the Committee; however, different positions will be expressed on certain sections of the proposed permanent standard by industry members in the course of this proceeding. The Committee is unanimous in its position that the proposed permanent standard is not technologically feasible and, if adopted, would shut down the industry.

The PVC and vinyl monomer producers are aware of the experimental work of Professor Maltoni and Industrial Bio-Test Laboratories in which angiosarcoma of the liver has been reported in both rats and mice at long-term exposure levels as low as 50 parts per million. We are also aware of the fact that in recent work reported by Professor Maltoni the angiosarcoma which developed in rats following long-term exposure at 50 parts per million occurred at the end of their normal lifespan.

Dr. Marcus Key of NIOSH, in his letter to the Department of Labor on March 11, 1974, made the following comment, and I quote:

"Based on theoretical considerations there is probably no threshold for carcinogenesis although it is possible that with very low concentrations the latency period

might be extended beyond the life expectancy" -- end of quote.

The recent results of Professor Maltoni of rats exposed to 50 parts per million indicates that the latency period was approaching the lifespan of rats which we understand is equivalent to 80 years human lifespan.

In turn, we all must be aware of the inherent uncertainties of extrapolating from animals to humans and also from high levels of exposures that existed in our plants in earlier years to those that exist today.

The exposure of workers to vinyl chloride has varied with the age of the industry. In the 1940's the degree of exposure of workers to vinyl chloride was no doubt greater than in the 50's and, in turn, the 50's versus the 60's, and so forth.

Unfortunately, records are not available on the precise level of exposure with respect to periods of the industry's history. In order to get some estimate of exposure levels in history we must depend on the recollections of the employees so to levels of odor and work practices and to reconstruct today conditions considered to exist thirty and twenty and ten years ago. To the extent that this has been done, we believe that the average exposure in the decade of the forties could have been some forty times greater than they are today. With respect to peak exposures, they no doubt were some hundred times of today's emergency standard of 50 parts

per million since employees were known to have become mildly intoxicated from exposure to vinyl chloride.

On the basis of this background of information, it is only prudent that we continue to decrease the level of exposure of our workers. While it can be argued that there is no safe level of exposure, the basis of the proposed standard, it can similarly be argued that there is no data showing that exposure levels as provided for under the emergency standard are not safe or of low degree of risk.

The current levels of exposure, when considered in the light of the past exposures especially in the decades of the 40's and the 50's, certainly must be considered in judging the degree of risk of a standard above the "no detectable level." It is simple to assume zero exposure and, therefore, zero risk. The only practical way of accomplishing this is to shut the PVC industry down or to impose work practices which will create a greater immediate risk to health and safety than exposure to low levels of vinyl chloride.

It is the position of theindustry -- which I will detail later -- that it will commit itself to lowering exposure of its workers by a combination of lower levels of vinyl chloride in the work atmosphere and work practices. Such a commitment cannot be accomplished overnight since, in certain areas, the technology for accomplishing it is as yet not developed and, when developed, facilities must be installed,

requiring time for engineering, procurement, and installation.

We fully recognize that there are those who will say that the industry can do better than it says and, therefore, tighter restrictions should be imposed than proposed by the industry. It should be recognized that the proposal which I will make later has already taken into consideration projections for improvement which are not in hand but depend on new developments and additions to facilities.

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Following the war, many new uses were found for PVC because of its versatility and inherent performance qualities. Today it is used in hundreds of PVC products and also in the production of essential components of many other assembled products. Hundreds of thousands of workers are employed

in industries that produce or depend on PVC for the manufacture of countless products.

The production of vinyl chloride, its polymerization into PVC resin, and the processing of PVC resin into semi-finished or finished products is treated in the proposed permanent standard as one industrial health problem. However, each is an entirely different manufacturing operation posing its own problems, permitting and requiring different solutions. Of the hundreds of thousands of workers whose jobs are dependent on PVC, only 6,500 are involved in the manufacture of vinyl chloride and polyvinyl chloride resins.

Furthermore, that segment that involves the production of polyvinyl chloride is not monolithic in operation. Several different processes are utilized with many process variations and with a wide variety of polyvinyl chloride resin products. Current installations are extremely varied and do not lend themselves to the simple solution of a restricted area where employees would only work for a brief part of the workday and, thus, be able to utilize self-contained breathing apparatus as provided for in the proposed permanent standard.

The imposition of the "no detectable level" as provided for in the proposed permanent standard would require the full-time utilization of self-contained breathing apparatus during the work period in vinyl chloride and in PVC resin producing facilities. This would impse a severe and

unnecessary physical burden on our workers as well as a potential health and safety problem. Further, because of space limitations, it is impossible to use self-contained breathing apparatus in cleaning reactors.

Historically, the greatest exposure of workers to vinyl chloride has occurred in the polyvinyl chloride production segment of the industry.

Currently the level of exposure is lower in the vinyl chloride production segment of the industry. Nevertheless, the imposition of a "no detectable level" standard for this segment of the industry as proposed would, as in the case of the PVC resin plants, require the full-time utilization of self-contained breathing apparatus with the problems and potential hazards I have already mentioned.

The third segment of the industry is that of processing and fabrication where the level of exposure is the lowest. Available data indicate that worker exposure in most work areas is at "no detectable" levels as defined by the proposed standard.

The areas of potential exposure are those involving bulk unloading, storage, and mixing areas. Even in these areas it appears that level of worker exposure can be reduced to low levels by known engineering solutions. In addition, the reduction of residual vinyl chloride monomer in the PVC resin by the PVC resin producer will further lower the potential of

worker exposure.

Since the problems of worker exposure in processing and fabricating plants are limited and engineering solutions are available, this segment of the industry should not be subjected to the full coverage of the proposed permanent standard.

With respect to PVC resin and vinyl chloride, the producers have stated that a "no detectable level" for vinyl chloride, as defined, would shut down the industry.

As stated earlier, it is not feasible to require workers to continually use self-contained breathing apparatus.

Therefore, there are only two ways to seek a "no detectable level": to eliminate all losses of vinyl chloride or to dilute losses through ventilation.

Neither of these alternatives arefeasible, in our judgment, because losses from processing equipment will always occur. Some are identifiable and others are fugitive losses.

The fugitive losses are those losses which occur from mechanical equipment, such as valves, pumps, flanges or fittings, column manheads, reactor manheads, and so forth, and impossible to quantify. All plants have hundreds of valves, pumps, flanges, and so forth, all of which are a potential source of small leaks and which must receive constant attention. This is especially true in older plants with small reactors.

The industry has for years tried to improve its

losses from this source, has made progress and should continue to make progress. Nevertheless, this one type of loss will, in today's plants, provide detectable levels of vinyl chloride in many work areas. This is the primary source of vinyl chloride in the work atmosphere of today's polyvinyl chloride and vinyl chloride plants.

The identifiable losses are those losses which take place from our processes which are inherent in today's plants. While we know of their existence, they are not precisely measured but can be estimated. Technological improvements requiring time for research and development, followed by procurement of equipment and installation, can reduce these losses. Any timetable projecting lower levels of exposure is dependent on projection of technological achievement.

The industry has made progress in reducing its losses of vinyl chloride as well as polymer from its processes. I am aware of newer PVC resin plants which have reduced total losses of PVC resin and vinyl chloride to 2 percent. This compares to an approximate 5 percent for the industry in total.

The industry recommends the following standards for polyvinyl chloride resin plants as representing the maximum reduction which a majority of the industry believes feasible:

Effective October 5, 1974, a ceiling of 40 parts per million of vinyl chloride and a maximum daily time-weighted average of 25 parts per million. Levels above 40 parts per

million would require the use of practical and effective respiratory protection.

Effective October 5, 1975, a ceiling level of 25 parts per million with no time-weighted average. Levels above 25 parts per million would require the use of practical and effective respiratory protection.

Effective October 5, 1976, a ceiling level of 25 parts per million with a maximum time-weighted average of 10 parts per million. Levels above 25 parts per million would require the use of practical and effective respiratory protection.

That sequential monitoring be required of work areas with proper alarms to limit exposures to those recommended. The peak exposure levels would be determined by the sequential monitoring system with a built-in 10-minute average sample and/or by a 10-minute grab sample. Instantaneous readings for determining exposure levels are highly unreliable.

The location and number of sampling points would be determined by statistical methods to make certain that the measurements represent the work areas.

The state of the technology today is one where excursions of vinyl chloride in the work atmosphere for one reason or another do occur, although the average level of vinyl chloride in the work atmosphere throughout the day is considerably below the level of such excursions.

The imposition of the 40 parts per million ceiling would require the utilization of respiratory equipment for those periods of time when such excursions occur and when corrective action is taken.

The utilization of respiratory equipment for this purpose would not be excessive and, therefore, feasible. The adoption of a 25 parts per million time-weighted average exposure as of October 5, 1974, would in practice result in substantially lower time-weighted average exposure for the working population than indicated by the 25 parts per million time-weighted average since this is a time-weighted ceiling.

The adoption of a 25 parts per million ceiling as of October 5, 1975, would require industry to make substantial progress in reducing levels of exposure during the one-year period. A 25 parts per million ceiling will further substantially reduce the time-weighted average exposure. Theoretically, it could allow for an occasional 25 parts per million time-weighted average. However, exposure in such event is highly unlikely and would be rare.

The further imposition of a 10 parts per million time-weighted average standard on October 5, 1976, would, again, provide assurance of lower levels of exposure for, again, the 10 parts per million time-weighted average would become a ceiling by this method of measurement and, in practice, would result in substantially lower time-weighted average exposure

for the working population.

The industry believes it is feasible to operate under more restrictive standards in its vinyl chloride monomer producing operations.

The industry recommends the following standard for levels of exposure in its vinyl chloride monomer producing plants as representing the maximum reduction which a majority of the industry believes feasible:

Effective October 5, 1974, a ceiling of 25 parts per million and a maximum time-weighted average of 10 parts per million. Levels above 25 parts per million would require the utilization of practical and effective respiratory protection.

Effective October 5, 1975, a ceiling of 10 parts per million and a maximum time-weighted average of 5 parts per million. Levels above 10 parts per million would require the utilization of practical and effective respiratory protection.

As in the case of the polyvinyl chloride resin plants, the adoption of a time-weighted average standard would result in a practical exposure below those ceiling time-weighted average values.

It should be recognized that these proposals represent ambitious, difficult levels of operational exposure dependent on large expenditures of money, reduced capacity, and the development of technology not currently in hand. Many companies will probably require variances of time or methods;

therefore, provision for such variances should be made in the permanent standard.

It should also be recognized that medical and epidemiological data may be developed in the meantime which will require or allow a re-examination of the proposed levels.

We will present testimony later in these hearings as to the feasibility of utilizing canister masks for protection for short periods of time. It is recommended that the utilization of canister masks be permitted when adequate.

The proposed permanent standard calls for the utilization of self-contained respiratory apparatus and an air-supplied impervious suit when cleaning vessels and doing other types of maintenance work. Such a proposal is not feasible, potentially hazardous, and is unnecessary.

It is recommended that air line-supplied respirators be permitted for such operations and, further, that water impervious clothing be used instead of air-supplied suits.

Earlier in this testimony I pointed out that the processing and fabricating segment of the industry currently has a low level of exposure and that problem areas can be solved by engineering methods.

The proposed permanent standard calls for labeling of polyvinyl chloride containing detectable levels of vinyl chloride as to its containing vinyl chloride, a cancer suspect agent absorbed by breathing and through the skin. Such action

would essentially require that all polyvinyl chloride be so labeled and is inconsistent with prior standards with carcinogenic chemicals.

In view of the data which has been obtained in fabricating plants, it is recommended that appropriate labeling, as has already been discussed by Mr. Heckman, be required of polyvinyl chloride on October 5, 1974, only when the level of vinyl chloride in the polyvinyl chloride exceeds 0.1 percent.

The industry realizes that it is prudent on its part to reduce levels of vinyl chloride in the polyvinyl chloride resin and, therefore, will attempt in a short period of time to carry out the necessary research and development activities and, assuming success, procure and install the necessary facilities to reduce the vinyl chloride monomer content of polyvinyl chloride resin.

We believe it difficult, but feasible, by October 5, 1977, to have the major volume of polyvinyl chloride resin produced with less than .01 percent or 100 parts per million of vinyl chloride in the polyvinyl chloride. The labeling level could then be dropped to .01 percent or 100 parts per million.

JUDGE MYATT: Mr. Heckman, I'm going to modify my order of yesterday and I'm going to suggest that after your group that sits at the table has given their presentation that they be then subject to cross-examination. Given the, as Mr. Harding indicated, a horrendous list of people who are going

to testify here, and I think it's unfair to wait until it's all concluded before questions are directed to the witnesses.

Therefore, at this point, after I have identified for the reporter, the statements given to me, we will have examination of those of you who are sitting there by the Department and by the people in the audience.

For the record, Madam Reporter, Mr. Harding's statement is 20(b), Mr. Heckman's statement is 20(c), and Mr. Vittone's statement is 20(d).

(Exhibits Nos. 20(b), 20(c), and 20(d) were marked for identification and were received in evidence.)

JUDGE MYATT: All right, gentlemen. Take your best shots.

MR. KLEIN: Would you believe I have some questions?

Before I start asking questions, is somebody up there qualified to deal with technical feasibility in detail?

MR. VITTONE: I'm probably the best qualified.

MR. KLEIN: Okay.

Is anyone else going to make a presentation with respect to technical feasibility?

MR. VITTONE: No, not within this group.

MR. KLEIN: Mr. Harding, at page 5 of your testimony you've indicated that vinyl chloride constitutes potential health hazardswhich must be overcome. I'd like for you to tell

us what those health hazards are, please.

MR. HARDING: As have been discussed in this hearing thus far, the concern that led first to the 50 parts per million in your proposed standard at "no detectable level."

MR. KLEIN: Would it be reasonable to assume that you have treated vinyl chloride as a carcinogen in making your proposal?

MR. HARDING: I think you're asking a medical-technical question that I would rather have you ask of witnesses to follow than me.

MR. KLEIN: I don't believe I have, sir. What I've asked is: have you treated it as a carcinogen in making your recommendation?

MR. HARDING: Have I -- has our group treated it as a carcinogen?

MR. KLEIN: Yes, sir.

MR. HARDING: Certainly as a potential carcinogen.

MR. KLEIN: Mr. Heckman, at page 8 of your testimony you indicated that you felt that -- that SPI felt that the standard should cover only VC and PVC resin establishments and that with perhaps minor exceptions be limited to them. What exceptions did you contemplate?

MR. HECKMAN: Well, we would contemplate that the fabrication plants be required to comply appropriately with the other OSHA clean air standards and ventilation procedures to

take care of the few areas which have been determined to present a problem as far as capability for exposure is concerned.

There will be other witnesses who will present test data that, at least to me, indicates that the fabrication and processing plants pose a very, very limited problem, if any at all, and there only in a few selected areas, and that these can be taken care of by ventilation and work practices.

MR. KLEIN: I'm somewhat confused, sir. Are you proposing that these minor exceptions that you've indicated be included in the standard?

MR. HECKMAN: Actually, I think it would probably be better if they were covered by a separate standard or by a special work practice provision in this standard to cover them. In other words, that they would be excluded provided adequate ventilation and work practices were instituted to take care of the unloading and mixing areas which seem to be the only ones that present any problem at all.

MR. KLEIN: Do you or will you have any specific recommendations with respect to the fabricators?

MR. HECKMAN: We have put some in the table and we'd certainly be glad to propose additional language if that proves unsatisfactory.

MR. KLEIN: Okay. Thank you.

MR. HECKMAN: We'd be glad to work with the

Department on that.

MR. KLEIN: The next question is related to the last one. The language that you've proposed on the bottom of page 9 and page 10, I'm not exactly clear as to why you've made that specific proposal, and if you could elucidate that, I'd appreciate it.

MR. HECKMAN: On the bottom of page 9 and the top of page 10 of my testimony?

MR. KLEIN: Yes, sir.

MR. HECKMAN: Okay. The language that we've put in the table in this respect would exclude from coverage of the standard areas where vinyl -- polyvinyl chloride resins are received and have less than .1 percent residual monomer, so that they would not be covered by the standard as it's presently written.

Now, I've just indicated that if you feel that -- if the Agency feels that there really is a problem with the work practice -- with the unloading and mixing areas, we could probably live with either a separate standard on that particular aspect or with some language in this standard that would point out that special precautions have to be taken in those areas.

MR. KLEIN: Have samplings and monitoring, measuring, and the like been taken in the compounding areas and in the fabrication areas?

MR. HECKMAN: Yes, and there will be testimony by more competent witnesses on that score -- five of them, in due course.

MR. KLEIN: And I assume that documentary evidence will be submitted on that?

MR. HECKMAN: Yes.

MR. KLEIN: And we're talking about on page 10, also, of your testimony -- you would exclude people who would make deliveries and allow them to go into regulated areas?

MR. HECKMAN: Well, no -- yes, we would revise your rules so that even though it's unnecessary -- it's unnecessary for them to be in a PVC plant or a VC plant or a fabricating plant permanently, you could temporarily authorize people to enter such plants and allow them to be authorized personnel. This is not -- as the standard is now written, it would appear that they would have to be kept out of the plant altogether.

MR. KLEIN: I see. But whatever health and safety requirements there would be for regular employees, you would also suggest that they be applied to the --

MR. HECKMAN: Of course.

MR. KLEIN: -- outsiders?

MR. HECKMAN: Sure.

MR. KLEIN: Directing your attention to page 11 of the testimony, the numbers .1 percent and .01 percent residual monomer are indicated there. I'd like to know upon what basis

you've concluded, number one, that it's technically feasible to reach those levels -- and I'll ask more questions after that.

MR. HECKMAN: Well, I'm not sure that I have concluded that. That may be a better question to direct to Mr. Vittone as far as you can -- I've just been told that it's technically feasible to achieve these levels.

MR. KLEIN: Okay. Then I'll ask that question of Mr. Vittone --

MR. HECKMAN: I don't make any of this.

JUDGE MYATT: You'll ask that of Mr. Vittone later. Confine your questioning to Mr. Heckman.

MR. KLEIN: Your Honor, if I may request to just ask this question. I think in light of the large volume of the testimony, it would be much easier for me to keep track of each area.

JUDGE MYATT: I will confine you to one witness only at this point.

MR. KLEIN: May I ask the reason for that, sir?

JUDGE MYATT: That is my ruling.

MR. HECKMAN: Mr. Vittone makes that same proposal in his testimony, so, at least in this instance, I would think that you could get at the same subject.

MR. KLEIN: Okay. Mr. Heckman, at page 12 of your testimony you indicate that a minor spill under the proposal would constitute an emergency. Could you tell us what a minor

spill is, please?

MR. HECKMAN: Well, I think there are occasions, as I understand it, when an employee might get a drop of vinyl chloride on him as a result of a valve leakage or something of that type. All we're trying to do here is to clarify the language so as to try to distinguish between something meaningful and something minor.

I hate to keep passing you on to other people for more detailed technical information, but the language suggestion is just to distinguish what really is a relatively inconsequential occurrence from one that requires emergency-type action like evacuation, and I think, again, you can get more detail as to what takes place in a plant from another witness.

MR. KLEIN: Directing your attention to page 13 -- and, again, this is a somewhat technical question, and if you can't answer it, just let us know --

MR. HECKMAN: Right.

MR. KLEIN: You talk about above No. 6, the last sentence -- you talk about diced and/or pelletized compounds. Could you tell us what those are and why they should be excluded as well?

MR. HECKMAN: I was informed that the term "extrusion stock" was not an appropriate term and that such stock is sometimes extruded, sometimes diced, and sometimes pelletized, and

that all three of these end up in compounds that are somewhat comparable.

Again, with apologies, I'm just telling you what I was told, and there are witnesses here with us who can explain that in greater detail.

MR. KLEIN: That's okay. You know, if it's a technical question, you don't know the answer --

MR. HECKMAN: That's right.

I don't mind telling you at all why we made the language suggestion.

MR. KLEIN: I'll ask something in your area now.

MR. HECKMAN: All right.

MR. KLEIN: On page 14 you recommend that an elected employee --

MR. HECKMAN: Yes.

MR. KLEIN: -- be allowed to observe. Do you contemplate any specific procedures that would be utilized that would practical and feasible?

MR. HECKMAN: Well, I would think that in any plant, whether organized or unorganized -- and we deliberately left out that problem, because I didn't want to deal with it -- elections could be held among the employees to select somebody who would be responsible for that job.

MR. KLEIN: Who would you contemplate to run that election?

MR. HECKMAN: I think it could -- I really don't see it as a big problem. The employees could get together and run it -- or management could suggest that they get together and run it.

I don't think that would present a major difficulty in a country where everybody wants to run everything, anyway.

MR. KLEIN: That may be the difficulty.

Incidentally, along those lines, do you know what percent of the industry, say, at Stages 1 and 2 through PVC, are unionized?

MR. HECKMAN: I certainly do not.

MR. KLEIN: Let's talk for a moment about labeling and signs.

MR. HECKMAN: Okay.

MR. KLEIN: How would an employee under your sugge gestion know that there was a carcinogenistic hazard?

MR. HECKMAN: I really almost have to turn that question around and ask you what good it would do an employee to know that there's a carcinogenistic hazard. The cigarette labeling doesn't say carcinogen on it anywhere, to the best of my knowledge, and I think employees know that cigarettes -- employees and others know that cigarettes have the potential for causing cancer, and in that much more severe case -- I think Dr. Selikoff pointed out yesterday -- and made me sick every minute that he did it -- that cigarettes present a much

greater hazard than these types of things, and I just don't see what good it would do to advise employees about the nature of the hazard -- if you're telling them there's a hazard and telling them what to do about it, it seems to me that that's a lot more constructive. That's the thrust of our argument.

I don't understand what would be accomplished -- well, now, employees do have to be instructed as to the hazard independently of the signs and labels and they would be told in that way. There's no question about that.

Also, I think the newspapers and probably some television stations are going to do a pretty good job, too, of advising about the hazard, so that it will be as well-known as the cigarette hazard, and the important thing to do is to get instructions across as to how you take care of yourself, and that seems to me to be reasonable and what has been done in the past.

I just don't see much point in hollering, "Fire," in a crowded theater, is what I'm saying.

MR. KLEIN: Mr. Vittone, at page 2 of your testimony, the last sentence in the first paragraph, you indicated that the angiosarcoma observed in the Maltoni experiments were at the end of the normal lifespan. On what basis do you say that it was at the end of the normal lifespan?

MR. VITTONE: That statement, as I recall, was made by Professor Maltoni -- this is at the 50 parts per million --

MR. KLEIN: Correct.

MR. VITTONE: -- at the meeting in New York, the New York Academy of Science meeting on May 10th and 11th. I believe it was.

MR. KLEIN: So that these rats did not die of angiosarcoma? Did he make that statement as well?

MR. VITTONE: I believe he made that statement.

MR. KLEIN: At what level would an employee smell vinyl chloride?

MR. VITTONE: It's a very controversial subject at this point, and, of course, it will be gone into later on testimony.

The common figure that has been published lately has been 250 parts per million. On the other hand, there is literature reference and other possible data that might indicate 4,000 parts per million.

MR. KLEIN: Now, page 3 of your testimony you've indicated some general information about possible exposure generally to employees working in the past.

Do you have any specific information as to specific exposures of those employees who are known to have contracted angiosarcoma?

MR. VITTONE: No, we do not. We only have the reconstruction.

MR. KLEIN: Now, on page four of your testimony you've

indicated that if the PVC industry were to be shut down greater immediate risk to health and safety than exposure to vinyl chloride would result. Could you elaborate on that and indicate the basis for that and what the hazards are, please?

MR. VITTONE: Are you talking about the top of page 4?

MR. KLEIN: Yes, sir.

MR. VITTONE: The first full sentence?

MR. KLEIN: Yes, sir.

MR. VITTONE: What I said was the only practical way of accomplishing this is to shut down the PVC industry. That's one way we can obtain zero risk.

MR. KLEIN: Right.

MR. VITTONE: If you cannot reach a "no detectable level," you shut it down, you have zero risk, or you can impose work practices which will create a greater immediate risk to health and safety than exposure to low levels of vinyl chloride and I think trying to get all of your people in self-contained respirators on their back is creating a greater hazard than we will have at low levels of vinyl chloride.

MR. KLEIN: Is that the only hazard you contemplated by that statement?

MR. VITTONE: Safety hazards, yes.

MR. KLEIN: No, I mean with respect to respirators being a hazard. Are there other hazards associated with more stringent work practices that you're aware of?

MR. VITTONE: Well, in the utilization of respirators of one sort or another, yes. The standard, of course, talks about the self-contained type.

However, there are hazards in using other types also that we have to watch.

MR. KLEIN: There's been a lot of controversy as to whether employees are exposed throughout their entire workday to vinyl chloride or whether it's an intermittent exposure, they're in the area and then they're gone.

Do you have any specific information, for example, with respect to the PVC industry as to job classifications which would tend to have intermittent exposure as opposed to continual exposure?

MR. VITTONE: I could comment on that in general in behalf of the Goodrich Company rather than the industry, but I don't think the industry is very close to us in this case.

We have been taking very multiple -- numerous readings, of course, of vinyl chloride in the work areas. The numbers will vary, say, from almost zero up to above fifty, and, of course, we go into the respiratory equipment above the fifty level.

In our particular case the number above the fifty level will vary in a building, say, from floor to floor or from building to building anywhere from zero to 5 percent of the readings, so you have this type of situation.

The time-weighted average exposure can be very low in comparison to some of the readings sometimes.

There are, of course, certain operations where if you did not protect your employee with respiratory equipment, he would get much higher exposure. I'm talking about the cleaning of the reactor vessels, for instance. Today in our company we use respiratory equipment.

The reason I'm concerned about that is that if you loosen the polymer on the walls, you can get more vinyl chloride at times into the work atnosphere, so we take the adequate additional protection by using respiratory equipment during that period of time.

MR. KLEIN: What kind of respirator equipment do you use?

MR. VITTONE: We're using air-fed.

MR. KLEIN: I'm sorry?

MR. VITTONE: Air-fed respiratory equipment, hose, for this purpose.

MR. KLEIN: I understand that B. F. Goodrich is going to testify; is that --

MR. VITTONE: Yes, they are.

MR. KLEIN: Okay. Perhaps we can -- I guess it would be better to leave that until the specific areas.

You don't have any industry data with respect to job classification exposures?

MR. VITTONE: The general feeling of the industry goes historically as those who clean polymerizors were exposed more than others.

MR. KLEIN: I see. But do you have anything more specific than --

MR. VITTONE: No, I do not.

MR. KLEIN: Okay.

At page 7 of your testimony, the third paragraph, you've indicated that since there are engineering solutions to exposure to vinyl chloride in fabrication that the Act should not cover them.

What would you suggest be done with an employer who may not want to institute the appropriate engineering controls?

MR. VITTONE: I think what I said was this segment of the industry should not be subjected to the full coverage of the proposed standard. I did not say they shouldn't be covered by some standard.

MR. KLEIN: I see. All right. I misunderstood. Excuse me.

Is it difficult to measure exposure at a pump?

MR. VITTONE: Yes.

MR. KLEIN: What are the difficulties involved?

MR. VITTONE: You really don't know what you're measuring, you might say, because you could measure the exposure of the employee by trying to take a time-weighted

average at the breathing zone. This would be considerably lower than taking a reading at the packing gland that may be leaking slightly. Vinyl chloride does not disperse readily in the air. As a matter of fact, in taking spot readings, you can get a higher reading, say, at this point (indicating) and at that point a much lower reading, just a foot apart, so the best you could do as far as getting the level of exposure to the worker is by getting a time-weighted average.

Is that what you were after?

MR. KLEIN: Well, you've indicated that there are fugitive losses from --

MR. VITTONE: That's what I mean by fugitive losses. Very small losses that come out of a packing gland, either in a pump, a valve, or so forth. We are not able to quantify these. The way we go looking for them is by checking for leaks by methods we have available today to detect them.

MR. KLEIN: On page 9 of your testimony, the second paragraph, were you talking about unreacted monomer there?

MR. VITTONE: Yes, I'm talking about -- the losses of unreacted monomer and the losses of PVC resin itself. There's a loss of both.

MR. KLEIN: Do you have data which would in effect substantiate the figures you've given to us today?

MR. VITTONE: I don't have exact data. I was informed of the 2 percent by another company -- not in writing --

although we would in our experience in the B. F. Goodrich Company say that's probably correct.

MR. KLEIN: Would you be able to get some underlying data for that?

MR. VITTONE: I think we could, yes.

MR. KLEIN: And submit it in a post-hearing comment?

MR. VITTONE: Sure.

MR. KLEIN: Thank you.

I'd now like to direct your attention to the specific proposal made with respect to the PVC plants. I'd like to know how you arrived at a TWA of 25 and a ceiling of 40.

MR. VITTONE: This was arrived at on the basis of a judgmental consideration of the members of the industry. Not all of them agree that they can get to those figures by that point in time, necessarily. There's a big question on timing. It was finally decided on the basis of a vote that this would be what the industry would support, and it's a majority viewpoint. It's not a unanimous viewpoint, necessarily.

MR. KLEIN: Were there lower ranges that were suggested?

MR. VITTONE: I don't recall the lower range for that particular point in time, although there might have been, yes.

MR. KLEIN: Was there any factual or empirical data upon which these numbers were based?

MR. VITTONE: Well, of course, every company had

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their own data; every company knows what they are doing. Many are complaining that they're having a very difficult time on the present situation.

In our case, of course, we know our own data -- just talking for myself -- and we felt that this was a step in the reduction. We've only got a few months.

MR. KLEIN: How does one -- how can one project what level will be attained by the use of engineering and work practice controls if these controls are not in existence?

MR. VITTONE: They're not necessarily in existence, but we are making our best judgment, and, really, when we're talking about ceilings and the use of respiratory equipment above those ceilings, you're requiring -- if you do not make progress, of course, the greater the use of respiratory equipment under those ceilings.

What we're planning on doing, of course, is making progress and reducing these excursions above those ceilings such that we will not impose upon the worker a greater utilization of respiratory equipment in a period of time.

There are, of course, a number of areas where we hope to make additional progress. We talked about yesterday, for instance, reducing vessel entry. This is an area of great concern to all of us. In my own company we have a very large program in trying to find technological ways of further reducing entry into the vessel --

MR. KLEIN: Well -- excuse me. Go ahead. I'm sorry.

MR. VITTONE: The thing, of course, that I would like to see is the technology whereby we would very seldom have to even open the vessel, but we don't see that in sight yet. That doesn't mean we're not working on it.

MR. KLEIN: How would you reduce the number of times of entry into a vessel by technology or work practice?

MR. VITTONE: There are a number of ways. In my own company we have worked or developed in the -- starting in the mid-60s what we call a hydraulic reactor cleaner, and by the use of hydraulic reactor cleaning, we can cut down the entry into the reactor because we clean it mechanically.

This does not mean we do not have to go in from time to time because we have small amounts of resin that will build up on an agitator, and so forth, that has to be removed.

MR. KLEIN: How often would you have to go in, approximately, if you know?

MR. VITTONE: I'm trying to recall here from memory, but I would think that in this type of situation, it's very -- I should say it varies from polymer to polymer. To give you a specific figure is difficult, but it might be three to five charges before going in.

There are other methods that are being considered. Solvent cleaning, which was brought up yesterday is another approach to try and reduce vessel entry that's being worked on.

And, of course, there's always the ultimate that we'd like to see, and that is no build-up on the wall at all.

MR. KLEIN: Are you aware of any process or processes that would not allow for build-up on the wall?

MR. VITTONE: I'm not aware of any process that would not allow for any build-up on the wall, but we are investigating technically, are doing research and development in the area.

MR. KLEIN: Is there a Japanese process that comes very close to this?

MR. VITTONE: I understand it comes close to it, but they still open the reactor, as I understand it, every time and do have some entry.

MR. KLEIN: Why have you recommended the use of respiratory equipment for exposures over 40 parts per million?

MR. VITTONE: What we're trying to do is bring down the level of exposure at the excursion -- these are temporary excursions, as a rule --

MR. KLEIN: Is that -- excuse me. I'm sorry.

MR. VITTONE: -- and I'll have to admit it is a judgmental figure and not one based on scientific data. The curve -- any curve, as was pointed out yesterday, does not break off abruptly.

MR. KLEIN: Is it based on the fact that you deem it not technically feasible to prevent excursions below forty; is

that the primary thrust of it? Or is it in terms of protecting the employee against a level that you consider to be unsafe?

MR. VITTONE: It's in terms of trying to give greater protection to the employee.

MR. KLEIN: At page 10 of your testimony you've indicated that instantaneous readings for determining exposure levels are highly unreliable.

Could you explain to us why that is so, sir?

MR. VITTONE: Yes. If I may go back to the example that you asked me to comment just a few moments ago. It was the case of a pump leak. I pointed out to you that you can get an instantaneous reading at the packing gland, which has little meaning as far as the exposure to the employee. It's not at the breathing zone. It's instantaneous at that point.

And one of the other things that does often happen is that you may have a sudden surge that just lasts a second, say, going up to 40 ppm or something and then drop down.

MR. KLEIN: Now, in the next paragraph on page 10 you've indicated that some form of statistical method should be used to make sure that the measurements are accurate rather than a fluke. What did you have in mind there?

MR. VITTONE: You need a statistical anlysis of the work areas to make certain that the points that you're measuring the vinyl chloride in the atmosphere represents the work area that the employee will be in. You don't want to monitor

an area that he's not going to be working in because it has no meaning. What we want is the monitoring the area that the employee works in.

MR. KLEIN: And is there some process or procedure by which one could do this, or is that individual with each plant?

MR. VITTONE: I'm not that qualified to give you the details, but I have statistical people on my staff who are doing this.

MR. KLEIN: Now, let's stay on statistics for a moment. In order to get a statistical -- in order to get a reading that you have some statistical confidence in, how many times would you have to measure in a particular area over a given period of time? With respect to employees, how often would you have to do it in order to get some kind of statistical confidence in your view?

MR. VITTONE: I think we'd probably want to get measurements, in my view, again, in maybe every ten minutes or so of a point.

MR. KLEIN: At page 11 in your testimony you used the term "time-weighted ceiling." I'm not familiar with that term. Could you define it for us, please?

MR. VITTONE: Yes -- it's a very difficult thing for me to define. However, let me discuss it with you, if I may. What I'm trying to get across, and if I had charts, of course,

have done it better.

I think yesterday in talking on extrapolation, for instance, it was pointed out by one of the gentlemen that you have a bell-type curve -- you're familiar with the bell-type curve --

MR. KLEIN: I was always at the bottom when it came to grades.

MR. VITTONE: All right. If we were to plot, say, on the vertical axis the percentage of TWA's at various levels, say, from zero to a hundred, and on the horizontal axis plot the TWA value, say, from zero to 25, since that's the one you're looking at, and 25 is your limit. You better not have any points that are at 25 or above because you're in violation then. You've got to be below that. The number 24 is probably one out of a hundred or less. Therefore, that becomes the ceiling. The actual exposure average that you will have will be considerably below that ceiling.

If it were a perfect bell-shaped, you would say you would be half safe, but it won't be a perfect bell shape in practice; it'll probably have to be skewed toward the low level. That's why it's very difficult to establish a standard on the TWA. I realize that. Because actually the level of exposure will have to be much lower than 25.

That's the average, because you're taking these, say, for a four-hour period or an eight-hour period and you've got a

standard, and say you don't go over 25 on any one day. So if you have a man at 24 today, tomorrow he'll probably be down around 4 or 2.

The thing that we'd like to see, of course, would be an additive system where you could determine the exposure through the full week, but we don't have the technology to do that.

MR. KLEIN: Let me see if I understand you. If the time-weighted average were 25, then you could never go beyond 25.

MR. VITTONE: That is right.

MR. KLEIN: The time-weighted ceiling would be -- if one day you had 24, the next day you could have 26? That's at the highest excursion? Is that what you --

MR. VITTONE: The ceiling is any sample at one time, where we're placing the ceiling. That's what we have today in the temporary standard is a 50 parts per million ceiling.

Have I clarified it?

MR. KLEIN: Directing your attention to page 12, was the basis of those numbers the same as the basis for the numbers for PVC?

MR. VITTONE: Yes. It was obtained again by judgmental -- operations, looking at our data, and talking to the various members of the industry.

MR. KLEIN: And the use of respirators at above 10

parts per million, why did you include that?

MR. VITTONE: Again, the same type of thing; to provide greater protection for the worker.

MR. KLEIN: I'm a little bit confused. Perhaps you can help me with this. In PVC resins you allow employees to be exposed without respiratory protection at, say, 25 parts per million, but in the VC operations you would require a respirator, and I'm at a loss as to why.

MR. VITTONE: This is based on feasibility, and on feasibility you could do it in the VCM operations. The requirement would be rather limited, again, that they'd have to wear a respirator.

MR. KLEIN: I understand you have somebody on respirators?

MR. VITTONE: Yes.

MR. KLEIN: Okay. I won't ask you anything on that, then.

At page 14, I believe, you talk about the level of unreacted monomer. How did you arrive at the 100 parts per million figure? Why do you think it's technically feasible to get to that level?

MR. VITTONE: We arrived at the hundred by dividing by ten, as you can see, trying to set another level.

As to the technical feasibility, I think everyone in the industry is working on methods for removing the vinyl

parts per million, why did you include that?

MR. VITTONE: Again, the same type of thing; to provide greater protection for the worker.

MR. KLEIN: I'm a little bit confused. Perhaps you can help me with this. In PVC resins you allow employees to be exposed without respiratory protection at, say, 25 parts per million, but in the VC operations you would require a respirator, and I'm at a loss as to why.

MR. VITTONE: This is based on feasibility, and on feasibility you could do it in the VCM operations. The requirement would be rather limited, again. Only they'd have to wear a respirator.

MR. KLEIN: I understand you have somebody on respirators?

MR. VITTONE: Yes.

MR. KLEIN: Okay. I won't ask you anything on that, then.

At page 24, I believe, you talk about the level of unreacted monomer. How did you arrive at the 100 parts per million figure? Why do you think it's technically feasible to get to that level?

MR. VITTONE: We arrived at the hundred by dividing by ten, as you can see, trying to get another level.

As to the technical feasibility, I think everyone in the industry is working on methods for removing the vinyl

chloride from the polymer. Now, we're not saying that we're going to have it -- we're not saying that we're going to have all resin at that level by 1977, but we're saying that we think we can have the majority of it.

Now, as to technical feasibility, there are different approaches. One approach, of course, is trying to strip it out, as was mentioned yesterday -- strip it out by steam, and we have, of course, in my own company a pilot plant operation going for a certain resin in this area.

Not all resins are the same -- but, anyway, that is one approach.

Another approach is to try to react the remaining monomer with something else to convert it. That's the scavenger approach.

I think that might be considered and one probably highly unlikely to achieve technologically is to find a method to react that remaining vinyl chloride to make PVC out of it, but this is [illegible] technically -- it seems pretty far out.

Now, I'm also point out to you that not all resins are the same; that we've got certain resins that are much higher in monomer than others, and some of these resins we do not have clear as yet as to how to reduce them, necessarily, to this particular level.

The reason for the time frame, of course, is to complete what R and D we are doing today and the purchase and

installation of equipment to get there.

MR. KLEIN: Is it likely that the reduction in the unreacted monomer could have an effect on the quality of the resin which is produced? Is that a problem?

MR. VITONE: That is a problem, and that's just one of the things that we're working on in the R and D end as part of the technological study.

I'm sure anyone familiar with PVC realizes that it does degrade under high temperature and, therefore, you may have a problem if you're stripping under very high temperature.

MR. KLEIN: With respect to your plant, do you know how many parts per million there are monomer in the resin?

MR. VITONE: Yes. I can give you a feel for it. It's quite variable. In the plastisol-type -- I expected that question, so I jotted down a few notes, if I may -- in the plastisol or this Venidan type of resin -- this is the type of resin that the gentleman was talking about yesterday about making bolting -- an average figure would be around 25 parts per million. Now, that's an average figure. You have some above that and some below.

In the rigid -- well, let me see -- in high porosity extrusion resins, around 25 parts per million; co-polymers, in our case -- and by "co-polymers in our case," there's polymers and vinyl chloride and vinyl acetate and vinyl chloride, vanilladine (phonatic) chloride, we're well over a thousand.

We're in the 2,000 to -- we've got one product that runs as high as 7,000, I believe.

Our pipe-grade resin, on an average, about 150 -- there, again, it's an average figure, so you've got to -- a general purpose extrusion calendering resin, around 50.

That gives you a feel for it. There are all kinds of ranges, depending on the resin, and the most difficulty we are having, of course, is the polymers.

MR. KLEIN: Is that recent data that you've quoted?

MR. VERTOM: Yes.

MR. KLEIN: Is that data consistent with the results you've had over the years, or has there been some change?

MR. VERTOM: [illegible] been having to improve the vinyl chloride content on our resin and there has been, I'm sure, some reduction.

MR. KLEIN: Could you characterize the environmental concentrations of vinyl chloride that would result from processing PVC resins containing either 1 or 2 ppm monomer?

MR. [illegible] I'm already all ready to defer that question, since we've got four people who are going to talk on that subject a little later.

MR. KLEIN: Sure.

Could you tell us what a minor spill is in your view?

MR. VERTOM: Well, it's awfully difficult to discuss spills, because you have to talk about what you're spilling --

MR. SAMUELS: That is right.

And I just wanted to know if you would be willing to draw that line someplace, since you alluded to this in your testimony.

MR. BECKMAN: Well, I think we have made it pretty clear by means of Mr. Vittone's testimony, and the position that we have taken so far, that for the time being, until it is feasible, reasonable and possible to do better, that the levels we suggested were -- would appear to be an acceptable risk, and we think that we will hear, with a bit of patience, later in the course of this hearing that there is a sound, or reasonably sound basis for reaching that conclusion on the basis of the best kind of judgment that human beings are capable of making.

JUDGE MYATT: But we will never get there if we continue in this manner.

MR. SAMUELS: Mr. Vittone, how many dead and sick workers have you had identified in Louisville associated with your plants?

MR. VITTONE: I don't recall that number. You are speaking in real general terms.

MR. SAMUELS: Well, cases of angiosarcoma that your Medical Director has perhaps defined for you? Identified?-

MR. VITTONE: Now, you are being specific. Five deaths and two living.

MR. SAMUELS: In your considerations of the economic

burdens on your industry, have you taken into account the social costs, the impact on Louisville as a community?

MR. VITTONE: Up to this point in time, I have not taken economic considerations into my judgment as to feasibility. The proposed standard of non detectable; we are not able to estimate the capital required to get there because we don't know how.

MR. SAMUELS: Have you done any studies on recovery or recycling of PVC or VC?

MR. VITTONE: We have a large effort going on on methods of improving the recovery of VC from the polymer, such as decrease of the amount that goes into the air. That is under extensive consideration.

MR. SAMUELS: Are these studies in such shape that they might be shared with the public?

MR. VITTONE: They can now only be shared in the general term, in that the technology belongs to the Goodrich company.

MR. SAMUELS: Has your company done any intensive engineering studies on an operation by operation basis?

MR. VITTONE: I don't quite understand what you mean.

MR. SAMUELS: Well, do you look at an operation and try to see how exposure to workers in that operation might be reduced?

Statement of M. L. Keplinger, Ph. D., Manager, Toxicology
Industrial BIO-TEST Laboratories, Northbrook, Illinois
Prepared for Presentation at Department of Labor Hearings
on Vinyl Chloride; Occupational Exposure Standard
June 25, 1974

My name is M. L. Keplinger. I am presently employed at Industrial BIO-TEST Laboratories, Inc., Northbrook, Illinois, as Manager, Toxicology. I am here today at the request of the Manufacturing Chemists Association (MCA) and the Society of Plastics Industries to describe the chronic inhalation studies on vinyl chloride we are conducting under contract to MCA.

The research I will describe is supported by the voluntary contributions of thirty-one VCM/PVC producing companies. It is administered by MCA, with the advice and guidance of a technical panel of scientists from the sponsoring firms.

Industrial BIO-TEST Laboratories is an independent consulting laboratory. I am a toxicologist whose experience includes research and teaching at the Center For Toxicology, University of Miami Medical School, Miami, Florida for 8 years; toxicologist, Corporate Medical Department, Hercules, Inc., Wilmington, Delaware, for 4 years; and, toxicologist, Industrial BIO-TEST Laboratories for more than 6 years. I have had considerable experience in all types of toxicology including Industrial Toxicology.

At the 10th International Cancer Congress, Houston, Texas, May 1970, Dr. P. L. Viola, of the Regina Elena Institute for Cancer Research, Rome, Italy, reported 30,000 ppm VCM exposures at four-hours-a-day, five-days-a-week for a year, caused cancers of the skin, lung and bones of rats.

Professor D. C. Maltoni reported that rats exposed to vinyl chloride monomer at concentrations ranging from 250 ppm to 10,000 ppm showed Zymbal's gland carcinomas, nephroblastomas, and hepatic angiosarcomas. Rats exposed to 50 ppm did not have tumors.

Under my direction at Industrial BIO-TEST Laboratories, a study is being conducted to determine the effects from inhalation of vinyl chloride monomer to rats, mice and hamsters. The protocol for the study was designed by the Manufacturing Chemists Association. The study was designed as a life-span study in these species which means 1-1/2 to 2 years for the "in-life" portion, with tissue examination of pathologists and data evaluation to follow this period of time. It was anticipated that the total time of the study would be about 2-1/2 years.

The exposures of the animals was started on September 10, 1973, (which was about 9 months ago); therefore, the data to be presented are only partial results of a study which is in progress. In fact, the study is still in progress and is planned to continue. The final results are anticipated to be available about December 1975.

In this study which was designed to complement Maltoni's studies, 200 rats, hamsters and mice (100 of each sex or 600 animals total per exposure group) are being exposed to 50, 200 or 2,500 ppm vinyl chloride vapor 7 hours per day 5 days per week. Mice will be exposed for 9 months and kept for an additional 9 months. Rats and hamsters will be exposed for 12 months and kept for an additional 12 months.

The rats are COBS Charles River; mice are CDI Swiss Charles River; and the hamsters are Golden Syrian from the same source. Food is removed during exposure, water is present and no bedding is used at any time.

All 600 animals per level are exposed in a single chamber. The chambers are operated under dynamic conditions. The chambers are sealed and are operated under slight negative pressure. This is done so that, in case of an accidental leak, room air would flow into the chamber instead of contaminated air flowing out of the chamber.

The concentrations in the chamber are analyzed using gas-liquid chromatography. An automatic sampling device allows samples to be drawn from 3 locations in each chamber. The concentrations at all locations in each chamber are monitored every day during the total period of operation of the chamber. Therefore, data are available to substantiate that the concentrations of exposure of the animals are accurate and as reported.

INTERIM SUMMARY OF TUMORS IN MICE EXPOSED TO VINYL CHLORIDE FOR EIGHT MONTHS

:POSURE ROUP	NUMBER OF MORTALITIES WITH NEOPLASMS			TYPE AND LOCATION OF TUMOR			
				ALVEOLOGENIC ADENOMAS, LUNG	ANGIOSARCOMA, LIVER	ADENO-SQUAMOUS CARCINOMA, MAMMARY GLAND	METASTASIS OF MAMMARY TUMOR TO LUNG
	TOTAL	MALE	FEMALE				
ONTROL*	0	(7)	(2)	0	0	0	0
PPM**	4	1	3	2	2	2	2
0 PPM**	15	3	12	12	11	3	1
00 PPM**	30	6	24	28	28	6	1

* 7 Male and 2 females control mice have been examined histologically. None had tumors in spleen, liver, kidneys, heart, or lung.

** Only mice with grossly visible tumors have been examined histologically

Mice were exposed 7 hours/day, 5 days/week

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Note that no direct numerical comparisons can be made with the control groups as they have not been examined in the same way. Only mice with tumors have been examined in the exposure groups. No tumors have been observed grossly as yet in any of the control mice.

In addition to the tumors in mice, a few tumors have been observed in rats and hamsters but the diagnosis at this time must be considered tentative. At this time it appears that angiosarcomas may have been observed in one male hamster and one male rat exposed to 2,500 ppm and in one female rat exposed to 200 ppm. No tumors have been observed in rats or hamsters exposed to 50 ppm but one male control was found to have a dermal fibroma.

These tentative data need to be confirmed and will be reported in detail when the study is completed. For example, one could not at this time say an average exposure of 25 ppm is unsafe.

Since these data are preliminary in nature, conclusions from the results of the study at this time are even more preliminary. The question arises as to whether the tumors in the mice could have been spontaneous. Based on the type of tumor, particularly in the liver, and the age of the mice at this point in the study, these tumors do not appear to have been spontaneous in origin.

In comparing results from mice, rats and hamsters, it appears that the mouse is more susceptible than the other 2 species.

The relevance of these data in mice for prediction or extrapolation to effects in man at the same concentrations and durations of exposure are quite conjectural. It is known that mice are very different from man in size, life-span, respiratory rate, respiratory volume, metabolic rates, metabolic pathways, absorption, excretion, distribution, and many others. These facts should be considered when evaluating animal data for predicted effects in man; particularly when, as here, there has been considerable human exposure experience and the data in this respect are inconclusive.

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DOCTOR KEPLINGER: My name is M. L. Keplinger. I am presently employed in Industrial Bio-Test Laboratories in Northbrook, Illinois, as Manager, Toxicology.

I am here today at the request of the Manufacturing Chemists Association, MCA, and the Society of Plastics Industries, to describe the chronic inhalation on vinyl chloride studies we are conducting under contract to MCA.

The research I will describe is supported by the voluntary contributions of 31 VCM-PVC producing companies. It is administered by MCA with the advice and consent and guidance of a technical panel of scientists from the sponsoring firms.

Bio-Test is an independent consulting laboratory; I am a toxicologist whose experience includes research and teaching at the Center for Toxicology at the University of Miami Medical School, Miami, Florida, for eight years.

Toxicologist, Corporate Medical Department, Hercules, Inc., for four years, and Toxicologist at Bio-Test for more than six years.

I have had considerable experience in all types of toxicology, including industrial toxicology.

At the 10th International Cancer Conference in Houston, Texas in 1970, Doctor Viola reported that 30,000 ppm-VCM exposures at four hours a day, five days a week for a year

caused cancers of the skin, lungs and bone in rats.

Subsequently, Professor Maltoni reported -- and you have heard this about forty times in these hearings -- as reported originally that rats exposed to vinyl chloride monomer had concentrations ranging -- and I again say in the original work -- from 250 to 10,000 parts per million showed Zymbal's gland carcinomas, nephroblastomas, and apatic angiosarcomas.

At that point, rats exposed to 50 PPM did not have tumors, and it has now been reported by Doctor Maltoni that rats exposed to 50 PPM have shown such tumors.

Under my direction at Industrial Bio-Test, a study is being conducted to determine the effects from inhalation of vinyl chloride monomer to rats, mice and hamsters.

The protocol for this study was designed by the panel of scientists for the Manufacturing Chemists Association, the study was designed as a life-span study in these species, which means one and a half to two years for the in-life portion of the study, with tissue examination by pathologists and data evaluation to follow this period of time.

It was anticipated that the total time for the study would be about two and a half years. The actual exposure of the animals was started on September 9 and 10, 1973, which was about nine months ago. Therefore, the data to be presented are only partial results of a study, which

is still in progress.

In fact, the study is planned to continue, and it is anticipated that all of the final results probably will not be available until about December, 1975.

In this study, which was designed to compliment Maltoni's studies, 200 rats, hamsters and mice, 100 of each sex per group, or 600 animals total per exposure group, have been exposed to 50, 200, or 2,500 PPM vinyl chloride seven hours per day, five days per week.

The indicated mice will be exposed for nine months and kept for an additional nine months. Rats and hamsters are exposed for 12 months and kept for an additional 12 months.

The strains of animals are: rats, COBS-Charles River; the mice are CD-1, Charles River, and the hamsters are Golden Syrian from the same source.

Food is removed during exposure; the water is present, and there is no bedding used at any time.

The 600 animals per level are exposed in a single chamber. The chambers are operated under dynamic conditions; the chambers are sealed and are operated under slight negative pressure. This is done so that in case of an accidental leak, clean air would flow into the chamber instead of contaminated air flowing out of the chamber.

The concentrations in the chamber are analyzed using 441
gas-liquid chromatargraphy and an automatic sampling device allows samples to be drawn from three locations in each chamber.

The concentrations at all locations in each chamber are monitored every day during the total period of operation of the chamber. Therefore, data are available to substantiate the concentration of exposure of the animals and are accurate and as reported.

Moribund and dead animals receive gross autopsies; the major organs of all animals are fixed for histological examination. Only the tissues from a few animals have been examined histologically so far, and the main reason is that many of the animals are still alive.

Preliminary examination of tissues from mice that died after six or seven months of exposure indicated possible tumors in the liver, lungs, mammary glands and/or skin.

Therefore, on April 15, 1974, the MCA and Bio-Test presented these very preliminary data to the representatives of OSHA, EPA and NIOSH. At the present time, tissues are still being examined and evaluated from these animals and some that have died subsequently.

While the information must be considered as preliminary, it is being presented. In my presenta-

tion I do have a table which indicates exposures as far as concentrations, number of dead animals showing neoplasms to date -- and I will not read the whole table -- I would like, since the primary concern at this point has been angiosarcoma in the liver, I would like to go over that column for the benefit of those of you who don't have the table.

In the control animals -- and we have looked at some histologically, we have found no tumors. As far as angiosarcoma of the liver is concerned, therefore, there are none in controls; there have been two at 50 parts per million, 11 at 200 parts per million, and 28 at 2,500 parts per million.

I would like to emphasize that no direct numerical comparison can be made with the control groups, because they haven't been examined in the same way; we can not compare incidence in these studies because there are different numbers of animals that have been examined, and the results must be considered preliminary.

In addition to the tumors in mice, a few tumors have been observed in rats and hamsters, but the diagnosis at this time must be considered tentative. It appears that angiosarcomas have been observed in one male hamster and one male rat exposed to 2,500 parts per million, and in one female rat exposed to 200 parts per million.

There have been no tumors observed grossly to date

in animals which have died after being exposed to 50 parts per million.

These, then, tentative data need to be confirmed, and of course will be reported in detail when the study is completed, and at this point one can not say that an average PPM of 25 is unsafe because the studies have never been done.

Since these data are preliminary in nature, conclusions from the results of the study are even more preliminary.

The question arises as to whether the tumors in the mice could have been spontaneous. Based on the type of tumor, particularly in the liver, and the age of the mice at this point in the study, these tumors do not appear to have occurred spontaneously.

In comparing our results from mice, rats and hamsters, it does appear that the mouse is more susceptible than the other two species.

The relevance of these data in mice for prediction or extrapolation to effects on man at the same concentration, same durations of exposure, are quite conjectural. It is now known that mice are very different from man in size, lifespand, respiratory rate, respiratory volume, metabolic rates, metabolic pathways, absorption, excretion, distribution and many others. These facts should be considered when evaluating animal data for predicting effects in man, par-

ticularly when, as here, there has been considerable human experience, and the data in some respects still are inconclusive.

Thank you.

JUDGE MYATT: All right.

Do you want your other witness to go on?

QUESTION: On April 15th, when you reported the results, the preliminary results of your early findings, you reported in the mice two angiosarcomas.

DOCTOR KEPLINGER: Yes?

QUESTION: I notice today you are reporting that same number. Is it true that no mice have developed angiosarcoma since that date, the April 15th meeting?

DOCTOR KEPLINGER: As near as we can tell, yes, and please keep in mind we are only examining animals that have died, and that those same two or -- are the same two that you have seen today.

QUESTION: Do you have mice that have died in which you have not made the pathological determination yet?

DOCTOR KEPLINGER: We have not done complete histologies on the mice that have died, so we do have to reserve that for the future.

QUESTION: Of the 100 male mice that were initially exposed, how many of them have died?

DOCTOR KEPLINGER: I don't have those actual figures

MR. KEPLINGER: I do not think that I can necessarily agree.

I think that we have a lot more information to evaluate before we make a lot of statements.

MR. SAMUELS: You questioned the ability, rightly, I might say, to extraoplate to men animal data.

What is your reaction, then, to Mr. Vittone's statement earlier today comparing the Maltonian effects to effects that might occur to humans at age eighty?

Is that a fair kind of extrapolation or conjecture?

MR. KEPLINGER: Well, first of all, I have not really seen the Maltoni data.

As I recall, in the information that was presented early yesterday morning, and about a telegram, I think that the information conveyed to us was that these rats were about 134 weeks old.

Is that the information that you had?

MR. SAMUELS: Well, I am referring specifically to Mr. Vittone's statement.

MR. KEPLINGER: Well, all right.

All I am saying is that a 134-week old rat is a 30-year old rat.

[Laughter]

MR. KEPLINGER: And I do not disagree with Mr. Burton that that could possibly represent

as part of the life span a man who would be 80 years old.

MR. SAMUELS: On the basis of the data which you have described, what levels would you recommend for human exposure, or is the data such that you couldn't make any recommendations?

MR. KEPLINGER: I think I would prefer to hold off on a recommendation until we have some more data.

MR. SAMUELS: The testimony yesterday from the National Cancer Institute discussed in theoretical terms, the concept of safe levels of carcinogens.

As a physician, how do you feel about that?

MR. KEPLINGER: Well, since I am not a physician, I can't feel at all about it as a physician.

MR. SAMUELS: I thought you were a toxicologist.

MR. KEPLINGER: I am a Ph.D. toxicologist.

MR. SAMUELS: I see.

As a PH.D. toxicologist, do you have an opinion that you would like to venture?

MR. KEPLINGER: Well, we heard a lot of numbers yesterday and a lot of theories with numbers.

The one thing I didn't hear emphasized yesterday was that there is such a thing as biological response, and there are no effect levels for certain drugs and many other agents, and this end of the dose response has nothing to do with numbers and animals.

There is a level where you just don't get it. It

doesn't matter whether it is one animal or 100 million.

MR. SAMUELS: Isn't the no-response level tied directly to a specific effect?

If you look for another effect, you might not find it?

MR. KEPLINGER: If you look for another effect?

MR. SAMUELS: Yes.

For example, if you want to find out whether there are clinical symptoms of lead, that is one no-response level. And if you want to find out the psychological or behavioral effects, that is another.

You are talking about no-response levels.

MR. KEPLINGER: No.

You were talking about no carcinogenic responses, as I understood your question.

MR. SAMUELS: Would you get a different level for different target organs?

MR. KEPLINGER: That is possible.

MR. SAMUELS: So that there wouldn't be a line that would protect an animal or a human for all target organs.

Is that correct?

MR. KEPLINGER: I don't think you could make that statement.

MR. SAMUELS: Thank you.

JUDGE MYATT: Yes, sir?

I am sure the reporter didn't hear you. I didn't.

Would you identify yourself again, please?

MR. GEHRING: Harry Gehring, Dow Chemical Company.

Dr. Keplinger, I have seen some previous results, and it appears as though there was an increase in instance of deaths in all of the mice that were exposed, 50 parts per million and so on.

If this is the case, does this still hold true?

MR. KEPLINGER: Yes, this trend still appears to be holding true.

We appear to be losing more animals at the highest dose; fewer at the next lower dose; and still fewer at the 50 parts per million dose.

MR. GEHRING: I am trying to get at this specifically because I think Dr. Lassiter was trying to get some other parameters. And I think that was the case.

With reference to some of the testimony yesterday, it does appear that the mouse is more susceptible, not only to the tumorogenic capacity but also to the lethality of the exposures.

MR. KEPLINGER: Yes, that is true. And again we have not had time to evaluate or try to evaluate the actual cause of death. But there does appear to be a dose response effect here, whatever it is.

MR. GEHRING: Does the incidence of death, ballpark figure, would you say it is 10 percent greater or 1 percent

greater?

MR. KEPLINGER: Among the doses?

MR. GEHRING: Yes, at the low dose.

Would you say it is --

MR. KEPLINGER: It is probably at least 10 percent increase with every dose, increase of the dose.

MR. GEHRING: The reason I ask that question is because I think it should be put in the record that the protocol for testing materials for cancer recommended by the National Cancer Institute does so by saying that the maximum dose should not exceed that which causes a certain percentage of deaths.

MR. KEPLINGER: Yes.

MR. GEHRING: And actually in this case we are seeing results of the dose which is -- which exceeds that necessary to cause that percent of death.

MR. KEPLINGER: Yes.

MR. GEHRING: That is all I want to say.

Thank you.

JUDGE MYATT: Anyone else?

Yes, sir?

MR. CAPNOLLI: Doctor, have you seen Maltoni slides?

MR. KEPLINGER: No.

MR. CAPNOLLI: Do you know anyone who asked to see them and was refused the opportunity to examine them?

MR. KEPLINGER: We have been told that there have been

MR. SAMUELS: Doctor, were you here yesterday to hear Dr. Selikoff's testimony?

DOCTOR KEPLINGER: Yes.

MR. SAMUELS: Dr. Selikoff was specifically asked whether he would come to the same conclusion without the animal data. Would you agree with that? That is to say the carcinogenicity of vinyl chloride. Now, he said that he would be convinced without toxicological studies. Would you agree with that?

DOCTOR KEPLINGER: Well, I don't quite understand your question.

MR. SAMUELS: Well, last night, it was the night, I asked Dr. Selikoff if there were no animal studies, would he still be convinced of the carcinogenicity of vinyl chloride and he answered in the affirmative.

Would you agree with that?

DOCTOR KEPLINGER: Well, I don't think I can necessarily agree. I think that we have a lot more information to evaluate before we make a lot of statements.

JUDGE MARTZ: Thank you, sir.

We are going to take a five-minute recess.

[Short recess]

JUDGE MARTZ: Ladies and gentlemen, before we resume with the testimony, let me indicate to you now, because I know many of you are from out of town, that we are not going to run late tonight as we did last night.

order as they follow in the rest of our plans.

After this next witness, Vincent P. Ficcaglia, Industrial Economist, Arthur D. Little, Incorporated.

JUDGE MYATT: Before you start, Mr. Ficcaglia, we have the statement of Dr. Keplinger, which I did not designate in the record, and that will be Exhibit 20-E, and Mr. Ficcaglia's statement, Mr. Reporter, will be 20-F.

All right.

(The statements referred to were marked as Exhibits Nos. 20-E and 20-F.)

STATEMENT OF VINCE P. FICCAGLIA, MANAGER OF ECONOMIC ANALYSIS AND FORECASTING, ARTHUR D. LITTLE, INC., CAMBRIDGE, MASSACHUSETTS; ACCOMPANIED BY CHARLES H. JENEST, SENIOR STAFF MEMBER

MR. FICCAGLIA: I am Vince P. Ficcaglia, Manager of Economic Analysis and Forecasting of Arthur D. Little, Inc. (ADL) of Cambridge, Massachusetts.

ADL is an international consulting firm with revenues of $57 million in 1973.

Since joining ADL in 1967, I have been responsible for a wide range of economic and industrial consulting assignments, including responsibility over the past year for ADL's work in the areas of national and regional economic impact

analysis.

I am accompanied today by Messrs. Charles H. Jenest and George B. Hegeman, senior staff members of ADL's Chemical Consulting Management Group. Together, Messrs. Jenest and Hegeman have accumulated over 40 years experience in the chemical industry, with a large portion of this time devoted to the areas of petrochemicals and plastic resins and materials.

Let me add here, unfortunately Mr. Hegeman has had to return to Cambridge. However, Mr. Jenest is here, and the fact that Mr. Hegeman has left, we have lost 18 years work of chemical industry experience.

However, I do believe Mr. Jenest's 22 years will suffice for this hearing.

Together we are the authors of a report to be released this week -- we may want to change that -- by Arthur D. Little, Inc., prepared for the Vinyl Chloride and Polyvinyl Chloride Producers Committee of the Society of the Plastics Industry, entitled "United States Polyvinyl Chloride Resin Industry Impact Analysis."

Summarizing the conclusions of this report, we find that an immediate shutdown of all polyvinyl chloride (PVC) resin plants in the U. S. and the subsequent unavailability of PVC resin could result in a loss of 1.7 to 2.2 million jobs in consuming and related industries and a loss of domestic production value of $65 to $90 billion annually.

The extent to which materials could be substituted for PVC resin in the immediate term -- less than one year -- we believe is quite limited and therefore, would have an insignificant effect upon reducing the potential job and domestic production losses noted above.

Fact in the PVC resin industry:

Before describing the facilities of our company, I believe it is appropriate and would be most helpful to provide some background and informational discussion as to exactly what are PVC resin products.

In brief, vinyl plastics are among the world's [illegible] synthetic [illegible] first commercial plastic made from [illegible] (PVC) resin. The basic material for vinyl [illegible] polymer, was [illegible] 1930.

There are currently 22 domestic producers of [illegible] with a total of 36 plants in the U. S.

PVC resin is a powder material which is made from [illegible] which is [illegible] under standard conditions of temperature and pressure and a liquid when transported and [illegible].

PVC resin, as such, cannot be processed but must be [illegible] into a vinyl compound which contains several other additives such as plasticizer, stabilizer and colorant -- in addition to the basic resin, in order to fabricate it into useful product forms.

Because they can be compounded to yield a wide range of materials with specific properties, PVC resins are used in more applications than any other type of plastic material.

In some of product areas, the largest single product use of PVC resin is the extruded pipe and conduit -- 25 percent of the market. About 15 percent of all PVC resin is made into [illegible] sheet for packaging and coated fabric applications.

[illegible] vinyl insulation for wire and cable and [illegible] represent approximately 10 percent of the PVC [illegible] market. In addition, 5 percent of PVC resin is used as the major raw material input into the manufacture of phonograph records.

In the area of end-use applications, we have segmented PVC [illegible] into five distinct markets. The building and construction field is the largest single market for PVC and [illegible] accounting for about 43 percent of all vinyl usage. This includes pipe, flooring, building wire, siding, trim -- [illegible] and other products -- e.g., window frames, gasketing.

The motor vehicle industry is a very important outlet for PVC products such as upholstery, seat covers, floor mats, and some [illegible] under types -- insulated wire, and other components such as visors, dashboards, door panel covering.

The broad category of apparel and home furnishings, including upholstery for chairs and sofas, shower curtains,

table covers, and waterproof outerwear represents about 11 percent of the market.

A fourth PVC end-use module, which we have labeled specialty products includes phonograph records, telephone and telegraph equipment, and lighting and wiring equipment.

Lastly, a variety of products comprise our miscellaneous product module which includes luggage, handbags, toys, sporting goods, footwear, garden hose, packaging, credit cards, and medical tubing.

As a result of this myriad of product and end-use applications there are literally thousands of companies which purchase PVC resin and/or compound and use it to fabricate vinyl plastic products of different types.

The companies in the PVC resin industry have stated that they would be unable to meet the newly proposed "non-detectable" tolerance standard announced by OSHA. The industry has concluded that adoption of the proposed standard, as currently written would force the shutdown of all PVC resin plants.

In an attempt to measure the overall economic impact to the nation of an immediate shutdown of all PVC resin plants in the U. S., the Society of the Plastics Industry asked ADL to undertake an analysis to identify and quantify the potential loss in employment and domestic production that would be generated by such an event.

Impact analysis:

Because of the known widespread use of PVC resins in numerous applications in the U. S. today, the potential for lost production and employment would permeate beyond just the PVC resin, VCM, and their immediate customer markets.

Because of the high degree of interdependence among sectors of the economy and lack of adequate substitute materials, production cutbacks in PVC-related markets would lead to further output reductions in a whole host of materials and service supplying industries.

In order to capture the full extent of sectoral interdependence in our economy, we have employed ADL's Input/Output model. The model, which is based on the Input/Output table, originally developed by the U. S. Office of Business Economics for 1963, has been revised, expanded, and updated by ADL to reflect more accurately and in greater detail current relationships.

Input/Output techniques have been used by ADL on many occasions over the past ten years in much of its economic analysis and impact work.

In undertaking our analysis, we focused upon measuring the magnitude of the economic impact resulting from an immediate [illegible] of all PVC resin plants in the U. S.

With this as our basic focus, our approach included the following three steps:

1. Identification of PVC resin usage by product and end-use application: to best identify the use of PVC resin in the U. S. economy, we constructed five end-use applications modules which include:

(a) Building and Construction

(b) Motor Vehicles

(c) Apparel and Household Furnishings

(d) Specialty Products

(e) Miscellaneous Products

Construction of these modules allowed us to identify in a clear and complete fashion the flow and use of PVC resin in the U. S. today. Figures 1-5 appended at the end of this statement identify the products and end-use applications of each module.

2. Assessment of the extent of PVC resin dependency in each module: in order to accurately estimate the potential impact resulting from an immediate shutdown of PVC resin plants it was necessary to make explicit assessments of the extent of PVC resin dependency in each end-use application. Our analysis at this stage indicated that the dependency upon PVC resin varies significantly among the end-use applications.

For example, dependency is extremely high in such end-use applications as phonograph records, communications and building wiring, and medical tubing. On the other hand, PVC resin is not a primary material in paint, and converted paper.

3. Assessment of the potential for immediate substitution of other raw materials for PVC resin: the resulting economic impact based upon our analysis undertaken in Steps 1 and 2 had to be reassessed to incorporate the potential for immediate substitution of other raw materials for PVC resin.

In an effort to develop our best estimates of this potential, we gathered a team of ADL staff members with considerable experience in the areas of plastics and related markets and the product sectors which a priori offer themselves as possible substitution candidates.

After considerable research, coupled with numerous in-depth interviews with experienced representatives of a wide range of industrial sectors, the ADL team has concluded that:

Since all major classes of products made from PVC resin were made on a commercial scale prior to the introduction of PVC resin in the U. S. in 1939, it would seem, therefore, that it should be possible to use substitute raw materials in place of PVC resin.

However, because of the unique nature of PVC resin which, when combined with other materials, permits the formulation of hundreds of different compounds with wide ranges of properties -- from very soft to very hard materials -- it would not be possible, in fact, to duplicate the exact properties of vinyl plastic products by using substitute raw materials.

Even if it were possible from a physical property point

of view to make an "equivalent or acceptable" product derived from non-PVC resin-based materials, the costs of production and the resulting selling prices of the final products would probably be prohibitive in many cases and, in effect, price the final product "out of the market."

Assuming that (a) the substitute raw materials, most of which are now in very short supply and are likely to remain in "tight" supply for at least two to three years -- such as other plastics, rubbers, metals, paper, textile products, and glass -- will be available in sufficient quantity when needed, and (b) the physical capacity to produce the non-vinyl based end products is also in-place and operating when required, it would still take up to an additional three to four years to complete all of the necessary research and development leading to the required changes in product, process, and equipment design and the actual delivery and installation of new equipment in order to make such non-vinyl equivalent products on a commercial scale necessary to satisfy the demands of industry.

Based solely on technological factors, those substitute products which would take the longest lead time to develop are those that are critical products for the construction and motor vehicle industries. Such products include insulation materials for communication, building and automotive wire and cable, and automotive upholstery and related soft trim materials.

Based upon the three staged analysis outlined above,

we must conclude that the resulting economic impact to the U. S economy of an immediate shutdown of all PVC resin plants would equal approximately $65 to $90 billion of lost domestic production and a reduction in employment of about 1.7 to 2.2 million.

Because of the high degree of dependency on PVC resin in the building and construction and motor vehicle sectors, these two segments of our economy would suffer the greatest share of the total impact.

Unavailability of PVC resin will have production bottleneck effects in these areas in terms of insulated wire and cable, flooring, upholstery and many other materials.

In addition, because of the geographic fragmentation of these two sectors and their supplier-related industries, the economic impact of loss in production and employment would be felt by all regions of the country.

While our analysis did not include any assessment of the impact upon specific regions of the U. S., our work effort indicates that several areas of the nation currently suffering from depressed economic growth conditions and above-average unemployment rates -- the so-called depressed impacted areas -- would likely receive disproportionate shares of the production and employment reductions noted above.

Overall, an immediate shutdown of all PVC resin plants in the U. S. would generate an economic hardship of large magnitude that would create severe economic dislocations in many

local areas.

Thank you.

JUDGE MYATT: All right.

Mr. Kline?

MR. KLINE: Mr. Ficcaglia, did you study the question of whether or not the proposed standards would actually shut down the industry immediately?

MR. FICCAGLIA: Sir, our contract with SPI was not at all directed to that question.

We did not assess that at all in this study.

We were asked -- I am sorry. I will end my comment there.

MR. KLINE: Please go on if you have something to say.

MR. FICCAGLIA: I believe my statement here, I outlined specifically what our task was.

MR. KLINE: So, then, I assume that you have no idea as to whether or not the industry would be shut down by the proposed standards?

MR. FICCAGLIA: Not at all, sir.

MR. KLINE: When you take this type of study, will you tell us what types of sources you used for the underlying facts and material?

MR. FICCAGLIA: Certainly.

The basic model that I referred to here is a model which Arthur D. Little has developed during the last ten

MR. FICCAGLIA: Which information?

MR. KLINE: The information as to which plants, which industries would likely suffer harm, for example.

MR. FICCAGLIA: Well, there was, let us say, a two-step sort of procedure to get an answer at that question.

Part of our effort here, and I refer to it as one of the steps we went through, we did undertake a number of interviews with people in-house at ADL and outside of ADL. That gave us one part of the question of which industries would be impacted.

The second half, or the remaining industries to be identified, or and result of the ADL Input/Output. Part of the answer, shall we say, that that type of model will give you is an identification of all those industries that will be impacted by such an event as we were testing here.

MR. KLINE: Did you study the question of substitute products?

MR. FICCAGLIA: Yes, we did.

MR. KLINE: And how did you do that?

MR. FICCAGLIA: I, at this stage -- I don't know. I will ask Mr. Jonest who headed up that part of the study.

MR. JONEST: In the case of substitute materials, what we did was essentially to get together a list or a group of people within ADL who are quite known to the materials, plastics, rubbers, possible substitute materials such as

textiles, largely engineers, chemists, people of this nature. And we went through essentially the major end uses of PVC resins, such as pipe, flooring, upholstery material, wiring, et cetera. And we got indications from these individuals within our own company, and then in addition to that we went outside to the market place, to the industry, talked with producers of pipe, pouring insulation material with the basic people out there making these products.

We discussed in very distinct detail with them their thoughts as to the possibility of substitute materials.

So, with this as the basic resource of information, then we made estimates as to the degree of possible substitution that would be reasonable in the case of specific end uses and also the timing as to when that substitution might, in effect, take place, and taking into consideration the availability of substitute materials, as we indicated earlier are in very short supply and level.

And there are different degrees of substitution potentials.

MR. KLINE: Does your report go into detail as to possible substitute products?

MR. JENEST: Our report will indeed cover the subject of substitutions, and whether it is in detail -- and you would like to see it or not -- that is all right, but it will be covered in our reports.

MR. KLINE: I notice in the testimony, on page 1, and I quote, "The extent to which materials could be substituted for PVC resin in the immediate term (less than one year), we believe, is quite limited" -- did you study the question as to what would happen beyond one year?

MR. JENEST: Yes, indeed. That is the question of the time lag and the question of time lag, as it further was referred to here, our general feeling is that it would take up to three to four years before the full effect of substitution could be felt in this industry.

Part of that is the R&D that is required on materials, part of it is the research, technology required in processes, equipment design, and then the physical delivery of the equipment which, in truth, takes about two years minimum today. So, that after you do all your R&D prior to purchasing the equipment, it is still a couple of years before you can get the equipment into place to run, and that is the breakdown of the up to four year time lag.

MR. KLINE: In reaching this, these conclusions, did you actually go into the field to have people go into the field and speak to them in the record industry and communications industry and the like?

MR. JENEST: Absolutely.

MR. KLINE: Was that sort of a random type sampling?

MR. JENEST: Well, it was random, but we certainly

did it on the basis of knowing who the majors were in the industry, and we have a good sample coverage in the industry.

MR. KLINE: Does your document reflect who you have spoken to and the like?

MR. JENEST: The document does not at the moment reflect that, no.

MR. KLINE: Did you take into account any possible foreign manufacturer of PVC products?

MR. JENEST: Foreign manufacturer?

MR. KLINE: Yes.

MR. JENEST: Could you be more precise on that? There are many, many foreign manufacturers of PVC.

MR. KLINE: Well, did you take that into account in figuring the job losses downstream?

MR. JENEST: No.

This was strictly an analysis of the U. S. domestic economy.

MR. KLINE: Now, at page 6 in the testimony, you conclude that equivalent or acceptable products would probably be prohibited in many cases.

Could you tell us the basis of that?

MR. JENEST: Well, the complete sentence should be read so we will have the full context.

"Even if it were possible from a physical property point of view to make an (equivalent or acceptable)

product derived from non-PVC resin-based materials, the costs of production and the resulting selling prices of the final products would probably be prohibitive in many cases and, in effect, price the final product 'out of the market.'"

One of the cheapest and most versatile raw materials there is available, plastics and non-plastics, and when you substitute rubbers, for example, which you might consider to be a possible substitute, the price of rubber is higher on a per pound basis. And then when you add the price of vulcanizing, the steps that are required, I have no doubt that the cost of manufacture of the equivalent product, based on substitute product [illegible] would indeed be higher, much higher. I don't have the details for that.

Clearly, if the cost is higher, the price is going to go high. And it may be prohibitive for some markets.

MR. FLINN: Are you suggesting the fact that substitutes would be less expensive?

MR. JENNEY: No.

I am saying that substitutes would be more expensive. More costly to produce, and more expensive at the selling price level.

MR. FLINN: In the next paragraph, you indicate that the substitute materials are in tight supply for at least the next two to three years.

Does your report reflect what these materials are and why they will be in short supply for the next two or three years?

MR. JENEST: Well, this particular draft that I am looking at is not a final report. It will indeed.

MR. KLINE: And I assume the underlying basis for that is the same as others, that you have got your experts together and discussed it?

MR. JENEST: Well, no, this is the subject that we are constantly working on, the supply and demand of basic materials, such as rubbers and plastics, textiles. This is an ongoing business with A. D. Little so that we know the things that are right worldwide in many products.

MR. KLINE: Now, on page 7, you talk in terms, and I am reading the paragraph:

"Above non-vinyl equivalent products."

Do you mean non-vinyl chloride based products?

MR. JENEST: Yes, sir.

MR. KLINE: Could you briefly tell us how you arrived at your final figures, that it is the 65 to 90 billion and the 1.7-2.2 million in loss of jobs?

MR. PICCAGLIA: Certainly.

These will be detailed in the report. The 65 to 90 and the 1.7-2.2 million jobs represent the total impact by summing in the five modules that I referred to.

MR. JENEST: This was an assignment that I personally handled. I am a chemist and there were a number of other chemists and engineers within Arthur D. Little that were on the assignment. We did talk with a number of technical people and marketing people in the industry to reach our conclusions.

MR. FRIEDMAN: Any imput on the A. D. Little economists?

MR. JENEST: Well, I would hope so.

MR. FRIEDMAN: In what respect?

MR. FICCAGLIA: In that I am one and I did discuss this with my colleagues at ADL.

MR. FRIEDMAN: I would like to know what you were discussing.

MR. FICCAGLIA: Our thoughts on the availability of the so-called substitute material that we know are in tight supply as far as questions of substitution goes.

MR. FRIEDMAN: But as an economist you didn't think it was important to go into the issue of the possibility of increased imports?

MR. FICCAGLIA: We discussed that. It was then turned over to Mr. Jenest for his evaluation as to its availability.

MR. JENEST: If I may make a comment on imports, the world supply situation in all the materials is very, very tight and will remain tight for a couple of years. So that, if anything, United States is in better position relative to

the availability, potential substitute raw materials, than any other country that I can think of. 480

We couldn't import synthetic rubber, metals, and other potential substitute materials in anywhere near the quantities that were required to match these demands.

MR. FRIEDMAN: How about the reduction of exports from the United States, to provide the needs of the industries domestically?

MR. JENEST: The exports only represent about five percent, roughly, of the kind of materials that we are talking about, so if we restrict exports of synthetic rubber and PVC resin, polypropylene -- all the materials that might be substituted, it wouldn't make a dent.

MR. FRIEDMAN: How about the limitation on the exports of steel and cast-iron pipe, substitutes for PVC?

MR. JENEST: Well, actually, piping, there are many potential substitutes for PVC in pipe and metal is only one of several, and, again, I think the effect of the -- it would not be significant in our estimate.

MR. FRIEDMAN: Do you contemplate the fact that the steel industry exports have been growing?

MR. JENEST: I beg your pardon?

MR. FRIEDMAN: Do you contemplate the fact that the steel industry exports have been growing?

MR. JENEST: My guess they have been growing in

absolute terms. But I don't know whether steel pipe has been growing or not. I haven't looked into those. That seems to be -- you know, a broad statement. So steel has been growing in export.

MR. FRIEDMAN: Might I say that that is no broader than the statement that you delivered here this afternoon?

With respect to the input-output, use of the input-output table and the computation of the employment impact, how did you evaluate the job loss, let us say the automobile industry?

MR. FICCAGLIA: How do we evaluate it?

MR. FRIEDMAN: Yes, I take it there is some job loss in the automobile industry because of the loss of products that would go into the construction or production of cars?

MR. JENEST: Precisely.

MR. FRIEDMAN: How do you evaluate that?

Let me give you a hypothesis.

There is no more seat covering for automobiles as a result of the shutdown of the production of polyvinyl chlorides. What happens to the car they produce? Do they go out of the factory without seat covering?

MR. JENEST: They don't go out of the factory, period. There is no seat covering, no automobiles, shipped out of that factory.

MR. FRIEDMAN: What was built into your analysis is a complete shutdown of the auto industry as a loss of the seat cover?

MR. JENEST: No, it is not a complete shutdown of the automotive industry. There are products, I am sure, that are made by the automotive companies that are not passenger cars. And also in our analysis this is not only the OEM companies that make up the motor vehicle companies.

MR. FRIEDMAN: Which companies?

MR. JENEST: OEM, original equipment manufacturers. This also takes into consideration the ripple effect of automotive products in the downstream, the replacement markets. The numbers are not strictly The Big Four auto companies shutting down completely. This is a partial shutdown of partial plant activities.

MR. FRIEDMAN: I understand that. What I am trying to get at is that very little piece, the production of automobiles and the trucks; what would happen in your analysis to that production, that is what I would like to know, and unfortunately we are at a handicap because we don't have your report here.

MR. JENEST: Well, we know that PVC, the amount of PVC in an automobile only represents about three or four-tenths of one percent by weight of an automobile. But, in fact, it is a very critical part of the automobile, and we have been told by people in the automotive industry that the fact that they couldn't get PVC and they didn't have an immediate substitute, which they don't have, they would, in

fact, have to shut down the production of automobiles.

MR. FREEDMAN: Your analysis assumes the shutdown of the automobile industry or a significant part of it.

MR. JENEST: Not 100 percent.

MR. FREEDMAN: What percent?

MR. JENEST: A part of it.

MR. FREEDMAN: How big a part?

MR. JENEST: You will have to wait for our final report on that.

MR. FREEDMAN: May I ask whether the only part of the automobile industry that was left standing would have been that part that was not using vinyl covering?

MR. JENEST: Well, I think it doesn't leave us much, because, in trucks and buses and passenger cars we all have vinyl chloride products. Many as 800 different products in an average passenger car.

MR. FREEDMAN: I understand that. I am trying to understand what you, in your report and analysis, did in reviewing this.

MR. JENEST: Well, we didn't --

MR. FREEDMAN: To put it specifically, did you lose something in excess of half a million jobs because of the assumption made by your study?

MR. JENEST: Not on the -- in all automotive-related industries, yes, including not only manufacturing industries

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standard.

MR. FRIEDMAN: I think I have just one other question, Your Honor. And it relates to page 8 of your study.

In the middle of that concluding paragraph there is a statement that says: "Our work effort" -- I am picking up in the middle of a sentence -- "our work effort indicates that several areas of the nation currently suffering from depressed economic growth conditions and above-average unemployment rates would likely receive disproportionate shares of the production and employment reductions noted above."

I take it, since it is not included in this report, you cannot tell us which those areas are what you mean by several?

MR. PICCAGLIA: Sir, let me let you go away with a partial answer to that.

Our report will detail more to answer that question. But let me give you the following finding that we made during our analysis:

One area of the country that we are quite familiar with is the whole New England area. We talked to a number of people in the New England area. As a matter of fact, there are two fabricators here today. One in the New England Corporation and Preview Products, Inc. Both of these companies and a

number of other companies are located in northeast Wyoming, extending the definition of the eastern central part of New England.

We know of many firms located in the northeast part of Massachusetts, in particular, who are plastic fabricators or are consumers of fabricated plastic products. They are located currently in areas that over the past five or six years have been seeing unemployment rates average almost twice the national average.

To make you familiar, I hope, with the Lawrence-Lowell area of Massachusetts, currently experience then to twelve percent unemployment rates.

We have identified this particular area of Massachusetts in particular because of the concentration of the firms, are related PVC, as one area that is likely to receive a severe impact.

MR. FRIEDMAN: In the area you are talking about an area in which these sort of firms exist in greater proportion to other areas?

MR. FICCAGLIA: In regard to, say, the State, Commonwealth of Massachusetts, regions of New England, there is a preponderance of either fabricators or markets for fabricated plastic products in the area.

MR. FRIEDMAN: Let me ask you to turn to the preceding page.

You say at the bottom: "Because of the high degree

STATEMENT OF JOHN E. ERTEL
GENERAL MANAGER, ROBINTECH INCORPORATED
PREPARED FOR PRESENTATION AT
DEPARTMENT OF LABOR HEARINGS ON
VINYL CHLORIDE;
OCCUPATIONAL EXPOSURE STANDARD
JUNE 25, 1974

JUDGE MYATT:

I AM JOHN E. ERTEL, PRESENTLY GENERAL MANAGER OF ROBINTECH INCORPORATED, HEADQUARTERED IN FORT WORTH, TEXAS.

ROBINTECH IS A MANUFACTURER OF PVC RESIN IN PAINESVILLE, OHIO AND HAS A SECOND PVC PLANT UNDER CONSTRUCTION IN FREEPORT, TEXAS. ROBINTECH IS ALSO A LARGE MULTI-PLANT MANUFACTURER OF PVC PIPE, FITTINGS AND VINYL SIDING.

SINCE 1950, I HAVE BEEN IN THE EMPLOY OF THREE MAJOR PVC PRODUCERS, TWO OF WHICH WERE ALSO FABRICATORS, AS A DEVELOPMENT ENGINEER, SENIOR PROCESS ENGINEER, PLANT MANAGER, VICE PRESIDENT OF PRODUCTION AND MOST RECENTLY GENERAL MANAGER.

DURING THE PERIOD FROM 1950 TO 1965 MY JOB ASSIGNMENTS NOT ONLY RESULTED IN DAILY EXPOSURE TO VINYL CHLORIDE

AT LEVELS FREQUENTLY DETECTABLE BY SMELL, BUT ALSO RESULTED IN AN INTIMATE FAMILIARITY WITH ENGINEERING TECHNOLOGY AND WORK PRACTICES OF THOSE TIMES.

SINCE THE ANNOUNCEMENT OF RECENT FINDINGS SUGGESTING A LINK BETWEEN VINYL CHLORIDE AND ANGIOSARCOMA OF THE LIVER, I HAVE DIRECTED EXTENSIVE PROGRAMS ON BEHALF OF MY COMPANY TO DISCERN THE THEN CURRENT EXPOSURE LEVELS, THE REASONS THEREFOR, AND TO INITIATE ENGINEERING AND WORK PRACTICE CHANGES TO MINIMIZE THIS EXPOSURE. I HAVE ALSO HAD OCCASION TO MEET IN VARIOUS INDUSTRY TECHNICAL SESSIONS HELD UNDER SPI AUSPICES WITH OTHER VCM AND PVC PRODUCERS' REPRESENTATIVES SCHOOLED IN MANY RELEVANT DISCIPLINES. IN SUCH SESSIONS WE HAVE ATTEMPTED TO REVIEW PAST PROCESSES, WORK PRACTICES AND VCM EXPOSURE LEVELS IN THE WORKPLACE.

FROM JUNE 17 TO JUNE 19, 1974 A SUBCOMMITTEE OF THE VINYL CHLORIDE AND POLYVINYL CHLORIDE PRODUCERS COMMITTEE WAS CONVENED AND MET IN SPRINGFIELD, MASSACHUSETTS FOR A THREE-DAY "PROBLEM ANALYSIS" CONFERENCE. THE PLAN WAS TO UTILIZE THE KEPNER-TREGOE PROBLEM-SOLVING AND DECISION-MAKING ANALYSIS PROCEDURE APPLIED TO DATA AND INFORMATION WHICH WERE AVAILABLE AND RELATED TO THE 13 ANGIOSARCOMA CASES KNOWN TO HAVE OCCURED WITHIN THE RANKS OF THE VINYL CHLORIDE-POLYVINYL CHLORIDE MANUFACTURING WORKING

FORCE IN THE UNITED STATES. INCLUDED ALSO WERE SIMILAR, COMPARABLE DATA AND INFORMATION RELATING TO VINYL CHLORIDE AND POLYVINYL CHLORIDE MANUFACTURING FACILITIES WHERE CASES OF ANGIOSARCOMA HAVE NOT BEEN DETECTED. ALL OF THE COMPANIES WHICH HAD REPORTED ANGIOSARCOMA CASES WERE REPRESENTED AND A MAJORITY OF THE OTHER PRODUCERS PARTICIPATED FULLY.

FOR THE BENEFIT OF THOSE WHO ARE NOT FAMILIAR WITH THE KEPNER-TREGOE PROBLEM-ANALYSIS AND DECISION-MAKING PROCEDURE, IT MAY BE HELPFUL TO EXPLAIN THE PROCESS AT THIS POINT. THE PROCESS CONSISTS OF ASSEMBLING THE AVAILABLE INFORMATION PERTAINING TO A DEFINITE PROBLEM OR CONCERN IN A STRUCTURED FASHION. THE CONFERENCE LEADER WHO IS TRAINED IN THE PROCEDURE ATTEMPTS TO ASSURE THAT ALL THE PARTICIPANTS HAVE AN OPPORTUNITY TO CONTRIBUTE UNDER CONDITIONS THAT OPTIMIZE THE FREE EXCHANGE OF DATA AND OPINIONS. DURING THE COURSE OF THE ANALYSIS, IT BECOMES POSSIBLE TO MORE CLEARLY DEFINE WHAT THE SITUATION IS AND WHAT IT IS NOT.

FOLLOWING THE INFORMATION ACQUISITION PORTION OF THE ANALYSIS, A STRUCTURED SOLUTION PROCESS OF DEDUCTIVE REASONING IS FOLLOWED TO MAKE IT POSSIBLE TO REACH CONCLUSIONS ABOUT CAUSE AND EFFECT RELATIONS AND TO DEVELOP SOLUTIONS WHICH TAKE INTO CONSIDERATION ALL THE AVAILABLE INFORMATION.

THE KEPNER-TREGOE PROCESS IS DESCRIBED IN A TEXT PUBLISHED BY MCGRAW-HILL ENTITLED "THE RATIONAL MANAGER" AND WRITTEN BY DRS. KEPNER AND TREGOE, THE ORIGINATORS OF THE SYSTEM. THE KEPNER-TREGOE METHODS OF PERSONNEL TRAINING IN AREAS OF PROBLEM-SOLVING AND DECISION-MAKING ANALYSIS IS THE ONE MOST WIDELY USED BY U. S. INDUSTRY. THIS SYSTEM IS ALSO EMPLOYED EXTENSIVELY BY GOVERNMENTAL AND INVESTIGATORY BODIES. EXAMPLES OF THESE USES INCLUDE THE USE BY THE CIVIL AERONAUTICS BOARD IN DETERMINING CAUSES OF AIRCRAFT ACCIDENTS. IT IS ALSO USED BY NASA TO RESOLVE PROBLEMS ARISING IN VERY COMPLEX AREAS. TWO SPECIFIC EXAMPLES HAVE BEEN BROUGHT TO MIND. ONE WAS A RESOLUTION OF THE CAUSE OF THE FIRE IN WHICH THREE ASTRONAUTS WERE KILLED. ANOTHER EXAMPLE OF ITS USE BY NASA WAS IN THE SUCCESSFUL RESOLUTION OF THE CAUSES OF A MALFUNCTION THAT AROSE AT THE LAUNCHING OF APOLLO 13.

I AM ATTACHING AN UNEDITED SET OF WORKING NOTES USED BY OUR CONFERENCE GROUP. THE NOTES REPRESENT A COLLECTION OF DATA, OPINIONS AND SPECULATIONS THAT FORMED THE INPUT FOR THE ANALYSIS AND ARE SUBMITTED FOR THE RECORD SO THAT INTERESTED PARTIES CAN BE FULLY AWARE OF THE INFORMATION UPON WHICH THE CONCLUSIONS ARE BASED.

IN LIGHT OF THE FACT THAT SOME OF THE KEY ISSUES HERE CAN ONLY BE DEALT WITH IN TERMS OF PROBABILITIES, AS MR. HECKMAN NOTED IN HIS STATEMENT, WE BELIEVE THAT THE INFORMATION ASSEMBLED CONSTITUTES A CONTRIBUTION TO THE BODY OF KNOWLEDGE AVAILABLE, AND THAT IT DOES PROVIDE A SIGNIFICANT AND RELEVANT FOUNDATION FOR REASONED CONCLUSIONS.

WITH THIS PREMISE CLEARLY UNDERSTOOD, THE FOLLOWING CHARACTERIZATIONS WERE ESTABLISHED FROM THE AVAILABLE CASE HISTORIES OF THE AFORESAID 13 CASES OF ANGIOSARCOMA:

1. EACH INDIVIDUAL CASE WAS EXPOSED TO VINYL CHLORIDE FOR A MINIMUM OF 12 AND A MAXIMUM OF 30 YEARS PRIOR TO DIAGNOSIS.

2. EACH INDIVIDUAL CASE WAS EXPOSED TO HIGH TIME WEIGHTED AVERAGE (TWA) EXPOSURE TO VINYL CHLORIDE FOR A MINIMUM OF TEN AND A MAXIMUM OF 28 YEARS.

3. OF THE 13 ANGIOSARCOMA CASES, 12 WERE EMPLOYED FOR MANY YEARS IN POLYVINYL CHLORIDE MANUFACTURING PLANTS, AND ONE IN A VINYL CHLORIDE PLANT. THE LATTER WAS EMPLOYED FOR A BRIEF PERIOD OF TIME IN A POLYVINYL CHLORIDE PLANT AS WELL.

4. NONE OF THE 13 CASES WERE REPORTED TO HAVE HAD ACROOSTEOLYSIS (AOL).

5. No agent other than vinyl chloride monomer was found to be consistently related to the 13 cases.

6. Four of the ten fatal angiosarcoma cases were detected only upon retrospective examination of histopathologic preparations from the autopsy at the time of death.

7. No maintenance personnel such as pipefitters, electricians and the like who could have been exposed to high levels of vinyl chloride monomer were among the 13 cases.

As a result of the characterization of these 13 cases and considering the other available information presented in the attached summary, the following conclusions were reached:

1. All 13 cases of angiosarcoma of the liver were employees who had been exposed over long periods of time to continuous high levels of VCM. These levels were frequently above the odor threshold and were estimated to be a minimum of 500 ppm TWA and may have been as high as 2,000-4,000 ppm TWA. There is some controversy

IN THE LITERATURE AS TO WHAT THE ACTUAL THRESHOLD LEVEL IS FOR THE OLFACTORY DETECTION OF VINYL CHLORIDE. ONE SOURCE REPORTS 250 TO 500 PPM; ANOTHER USES AN APPROXIMATE 4,000 PPM FIGURE. MOREOVER, THE 2,000 TO 4,000 PPM FIGURE IS SUPPORTED BY RECENTLY GENERATED EVIDENCE FROM VERY SIMPLE EXPERIMENTS DEMONSTRATING THAT THE ODOR THRESHOLD IN INDIVIDUALS WITHOUT PREVIOUS EXTENSIVE EXPOSURE TO VCM IS APPROXIMATELY 2,000 PPM WHILE THE DETECTION ODOR THRESHOLD FOR INDIVIDUALS WITH CONSIDERABLE PREVIOUS VCM EXPOSURE IS INDICATED TO BE APPROXIMATELY 4,000 PPM.

2. THE DATA REPORTED LAST FEBRUARY BY DR. MALTONI INDICATES THAT THE DEVELOPMENT OF ANGIOSARCOMA IN RATS IS DOSE RELATED.

3. THE PRELIMINARY DATA REPORTED IN APRIL BY INDUSTRIAL BIO-TEST LABORATORIES, WHEN COMPARED WITH THE MALTONI DATA FOR RATS, SUPPORTS THE DOSE RELATIONSHIP CONCLUSION, BUT ALSO SUGGESTS A SIGNIFICANT DIFFERENCE IN SPECIES RESPONSE. THE INDUSTRIAL BIO-TEST MICE APPEAR TO BE MUCH MORE SENSITIVE THAN MALTONI'S SPRAGUE-

DAWLEY RATS, ALTHOUGH IT SHOULD BE RECOGNIZED THAT EXPCSURE CONDITIONS IN THE TWO CASES WERE SOMEWHAT DIFFERENT.

4. EVEN IF IT IS ASSUMED THAT THE 13 REPORTED CASES WERE CAUSALLY CONNECTED TO VINYL CHLORIDE EXPOSURE, THE EXAMINATION OF THE MALTONI DATA AT LEVELS OF 250 PPM AND HIGHER COMPARED WITH THE HUMAN EXPERIENCE AT LEVELS SIGNIFICANTLY HIGHER THAN 250 PPM INDICATES THAT THE SPRAGUE-DAWLEY RATS ARE SIGNIFICANTLY MORE SENSITIVE TO THE DEVELOPMENT OF LIVER ANGIOSARCOMA THAN HUMANS.

5. IT WAS OUR CONCLUSION THAT THE EMERGENCY TEMPORARY STANDARD WHICH SET THE MAXIMUM EXPOSURE TO VINYL CHLORIDE IN THE WORKPLACE AT 50 PPM APPEARS TO ASSURE THAT EMPLOYEES WILL NO LONGER BE EXPOSED TO ANY UNDUE OCCUPATIONAL HAZARDS. IT SHOULD BE NOTED, HOWEVER, THAT ADDITIONAL ANGIOSARCOMA CASES FROM AMONG THE VINYL INDUSTRY WORKFORCE ARE LIKELY TO BE REPORTED OVER THE NEXT TEN OR TWENTY YEARS DUE TO THE FACT THAT THERE ARE STILL MANY VETERAN WORKERS EMPLOYED WHO HELD THEIR JOBS DURING THE 1940's, 1950's AND EARLY 1960's.

IN THIS CONNECTION, IT WAS ALSO POINTED OUT DURING OUR SESSIONS THAT THE NEW ATTENTION BEING FOCUSED ON ANGIOSARCOMA OF THE LIVER, PER SE, IS VERY LIKELY TO LEAD TO INCREASED DIAGNOSIS OF THIS CONDITION IN THE GENERAL POPULATION. IN THE PAST, DIAGNOSIS OF THIS DISEASE WAS EXTREMELY LIMITED FOR ANY NUMBER OF REASONS. DIAGNOSIS OF ANGIOSARCOMA AS A CAUSE OF DEATH REQUIRES THOROUGH HISTOPATHOLOGIC EXAMINATION OF THE LIVER IN ADDITION TO REQUIRING GENERAL AUTOPSY AND PREPARATION OF SLIDES. THE EXAMINATION REQUIRES AN AWARENESS OF THE DISEASE SYNDROME AND A WILLINGNESS TO COMMIT TO IT AS A DIAGNOSIS. THERE HAVE BEEN RECORDED INCIDENCES WHERE CAUSE OF DEATH WAS ATTRIBUTED TO A GENERAL HEPATOMA AND UPON SUBSEQUENT RE-EXAMINATION BY SKILLED INDIVIDUALS WITH A HIGH AWARENESS OF ANGIOSARCOMA, IT WAS DETERMINED THAT THE DECEASED PERSON HAD DIED FROM ANGIOSARCOMA.

IN SHORT, IT WOULD APPEAR REASONABLE TO ASSUME THAT THE MUCH DISCUSSED RARITY OF THIS DISEASE MAY WELL HAVE BEEN OVERSTATED WITH RESPECT TO THE GENERAL POPULATION. IT WOULD BE UNWISE TO PLACE GREAT RELIANCE ON THE 25 CASES PER YEAR FIGURE FOR THE GENERAL POPULATION SO WIDELY PUBLICIZED IN THE PRESS AND ELSEWHERE AS AN AVERAGE AS A BASIS FOR COMPARING THE OCCURENCE OF THE DISEASE IN THE GENERAL

POPULATION WITH ITS OCCURENCE AMONG WORKERS IN THE VINYL CHLORIDE AND POLYVINYL CHLORIDE PRODUCING INDUSTRIES.

Ex. 20-I

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STATEMENT OF CARL U. DERNEHL, M. D.

ASSOCIATE MEDICAL DIRECTOR

UNION CARBIDE CORPORATION

PREPARED FOR PRESENTATION AT THE

DEPARTMENT OF LABOR HEARINGS ON

VINYL CHLORIDE

OCCUPATIONAL EXPOSURE STANDARD

JUNE 25, 1974

I am Carl U. Dernehl, M. D., Associate Medical Director of Union Carbide Corporation, testifying on behalf of the Society of the Plastics Industry. I am a board certified specialist in Occupational Medicine and have been practicing this specialty for more than 30 years. For 8 of these years I had medical supervision of a vinyl chloride monomer plant's employees and employees of a polyvinyl chloride plant. I have held teaching appointments at the Medical Branch of the University of Texas, the Baylor Medical School and, at present, at the Medical School of New York University.

The Society of the Plastics Industry has conducted a health survey of the polyvinyl chloride producers. This survey was conducted to determine if there are factories in which vinyl chloride exposure occurs and in which there have been no cases of angiosarcoma of the liver even though adequate exposure had occurred. Adequacy of exposure must be judged both by time and concentration of the toxicant.

In this survey, 36 plants of 20 producing companies were covered. Plants in which cases of angiosarcoma had occurred were discarded from the data. Becuase the most brief exposure period reported in existing cases was 12 years, all plants with 10 years operating experience or less were also discarded from the data as having exposure time insufficient to result in evidence of disease by current criteria. Accordingly, the data

covers 16 company plants which employ 2,372 persons currently in work permitting exposure to vinyl chloride, plus 1,471 persons who had worked with vinyl chloride in the past but do not do so now. Thus the survey is looking at 3,843 persons some of whom have not worked long enough to expect the disease to become evident.

However, 787 persons had worked more than 10 years with vinyl chloride and 1,402 persons had a time lapse since first exposure to vinyl chloride of more than 10 years. This last figure, called a latent period, does not require constant exposure but it covers those persons who may in the past have worked with vinyl chloride but do not do so now. The data shows 104 persons have been exposed to vinyl chloride for more than 20 years, but 416 persons have a time lapse from first exposure to the present time of 20 years or more. There are those who insist that any exposure to a carcinogen however remote in time initiates changes which ultimately result in cancer formation. If this be so, then we must accept the fact that we have here 1,402 persons who have the necessary time element for some of them to develop cancer. In addition, over one half of these 1,402 people have been continuously exposed for more than 10 years to vinyl chloride.

Having established that sufficient exposure in terms of time has occurred, attention must be directed toward the concentration of vinyl chloride in the air of the work place. Only 2 out of 16 plants indicated

existence of measurements of the environment prior to 1970. Because of the scarcity of data, the presence or absence of the characteristic odor of vinyl chloride was used as a measure of exposure. Vinyl chloride is believed to have an odor threshold in the vicinity of 250 ppm. Therefore, if the odor is detectable, vinyl chloride is present at least in a concentration of 250 ppm. The concentration may be much higher.

Three guide lines of exposure were used. The heaviest was when the odor of vinyl chloride was present most of each work day. Intermediate exposure was when the odor of vinyl chloride was present occasionally during a work day. Light exposure was when the odor of vinyl chloride was a rare event on any work day. Four companies reported that the odor of vinyl chloride was detectable most of the work day prior to 1960. Between 1960 and 1970 this condition was present in only 2 cases and after 1970 it no longer occurred.

All 16 of those reporting stated that the odor of vinyl chloride was present occasionally during the work day at some time in the plants history. Eleven said this occurred prior to 1960. During 1960 to 1970 the number increased to 15 cases and from 1970 to date the number is 10. It is interesting to note that in 3 cases there were process changes reported as occurring during 1960-1970 which resulted in increased escape of vinyl chloride thus largely accounting for the increased incidence of exposure.

The low exposure level reflects the general improvement which has been occurring in the industry. Before 1960 the detection of vinyl chloride odor was never a rare event but was common as already indicated. During 1960-1970 the situation improved where 4 of those reporting stated that odor detection was a rare event. In the period since 1970 this number has increased to 15 of the 16 reporting. There is some conflict in reports between intermediate exposure and light exposure after 1970. Thus 10 plants reported occasional exposure during a work day and 15 plants reported that exposure was a rare event. This discrepancy canhot be explained but it really is not too important since it refers only to the last four years.

In brief the data show that the 1,402 men not only had a significant time element in their work exposure but they also were exposed for much of the time to what must surely have been considerably more than a time weighted average of 50 ppm in recent years and most probably in excess of 250 ppm in years prior to 1960.

Since January 1, 1974, a total of 3,285 examinations have been made on employees of which 872 were made on retirees. The examination of 3,249 of these men included the liver profile tests found in the SMA-12, namely, bilirubin, SGOT, LDH and alkaline phosphatase. Fifteen per cent of those examined had an abnormal test result in one of the four tests in

the liver profile. This falls within the levels of abnormality we in Union Carbide have observed in approximately 900 employees who have not been exposed to vinyl chloride and also in 400 office personnel not exposed to any chemicals in their work place. The frequency of abnormalities in 2 tests (2.7 per cent) and 3 tests (1.3 per cent) in the same person also are comparable with control groups. This evidence suggests that workers in this survey group are not significantly different from their fellow workers who are not exposed to vinyl chloride in regard to liver function tests.

In summary, this survey has disclosed the existence of 1,402 men having a latent period of exposure to vinyl chloride of more than 10 years. Four hundred sixteen of them had a latent period of more than 20 years. Also, 787 men were exposed to vinyl chloride for more than 10 years with 104 of them being exposed for more than 20 years. Based upon odor recognition it is estimated that these men were exposed to a time weighted average of at least 50 ppm and in earlier years to much more than this. Examinations of these men have failed to show the existence of abnormal liver function tests in greater proportion than would be found in a control population. There is no case of angiosarcoma of the liver among these 1,402 men even though their exposure time is sufficient for disease to have occurred and exposures are believed to have been in excess of 50 ppm.

This absence of cases of angiosarcoma is supported by the independent epidemiological study conducted by Tabershaw-Cooper Associates for the Manufacturing Chemists Association who also found no new cases of angiosarcoma of the liver. A copy of the Tabershaw-Cooper study is attached for the record.

The plants in which cases of angiosarcoma have been found have an employment of 1,188 persons. The finding of 13 cases results in a ratio of one angiosarcoma for each 91 employees. If these plants are the same as the plants in this survey the incidence of angiosarcoma should be in the same ratio and we should have found 21 cases. The fact that not one case was found cannot be ignored. There are people in the survey group who have the same latent period as those seen in cases of angiosarcoma. This suggests that the difference lies in the degree of exposure which in the survey group is estimated at more than 250 ppm in early years and about 50 ppm in recent years.

We submit that these data fail to support the need for an exposure level as drastic as that proposed in the Standard, and in fact, these data suggest that the level of 50 parts per million proposed in the temporary emergency standard was not unrealistic.

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odor of vinyl chloride was present occasionally during a workday. And light exposure was when the odor of vinyl chloride was a rare event on any workday.

Four companies reported that the odor of vinyl chloride was detectable most of the workday prior to 1960. Between 1960 and 1970 this condition was present in only two cases, and since 1970 it no longer occurred.

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mediate exposure and light exposure after 1970. Thus ten plants reported occasional exposure during a workday and 15 plants reported that the exposure was a rare event. This comes to more than 16.

This discrepancy cannot be explained but it really is not too important since it refers only to the last four years.

In brief, the data show that the 1,402 men not only had a significant time element in their work exposure but they also were exposed for much of the time to what must surely have been considerably more than a time weighted average of 50 ppm in recent years and most probably in excess of 250 ppm in years prior to 1960.

Since January 1, 1974, a total of 3,285 examinations have been made on employees, of which 872 were made on retirees. The examination of 3,249 of these men included the liver profile tests found in the SMA-12, namely, bilirubin, SGOT, LDH and alkaline phosphatase.

Fifteen percent of those examined had an abnormal test result in one of the four tests in the liver profile. This falls within the levels of abnormality we in Union Carbide have observed in approximately 900 employees who are or have been exposed to vinyl chloride and also in 400 office personnel not exposed to any chemicals in their workplace.

included workers who died from the angiosarcoma of the liver are not included in the study, sir?

DR. DERNEHL: Practically all of these plants were also involved in the Tabershaw-Cooper study. In fact, I think all but two were involved in the Tabershaw-Cooper study and in that study they did go back and review the mortality data.

MS. HRICKO: One other question of the other plants that were already included in the same data as the Tabershaw-Cooper, this is in effect is not a new study at all, just the same results of the Tabershaw-Cooper and perhaps with less complete results.

DR. DERNEHL: No, it is not the same because of this particular circumstance we have attempted to fit these people into certain kinds of exposures.

We have applied to their work history both total exposure time and a latent period and we have selected out of this whole group--this particular group who worked long enough or had long enough latent period, they ought to have demonstrated disease if they were going to do it, or certainly they might be expected to demonstrate disease and have not done so.

Also, they have had a sufficiently long exposure time in terms of exposure to vinyl chloride that one might expect disease and it has not appeared.

MS. HRICKO: But any workers from these plants who

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EPIDEMIOLOGICAL STUDY OF VINYL CHLORIDE WORKERS

Final Report

May 3, 1974

Submitted to

The Manufacturing Chemists Association

1825 Connecticut Avenue N. W.

Washington, D. C. 20009

by

Tabershaw/Cooper Associates, Inc.

2180 Milvia Street

Berkeley, California 94704

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Monsanto Company

Olin Corporation

PPG Industries, Inc.

Shell Chemical Company

Stauffer Chemical Company

Tenneco Chemicals, Inc.

Union Carbide Corporation

UNIROYAL, Inc.

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IGURE

1. Flow Chart of Follow-up Procedure

T ACHMENTS

A. Plant Contact Form

B. Plant Background Form

C. Job History Form

D. Follow-up Letter

cancers, which however was inversely related to exposure. The explanation for this finding is not apparent.

INTRODUCTION

The study was begun by Tabershaw/Cooper, Associates, Inc. on ne 15, 1973, under contract from the Manufacturing Chemists Association. e original eight month period of the contract was later extended by two nths, in consideration of logistical problems arising from the number of ants which participated in the study.

The objectives of the study are:

(1) To compare the mortality of individuals who have worked in vinyl chloride plants with that of the general population;

(2) To compare mortality patterns within the population of vinyl chloride workers, based upon estimated occupational exposure; and

(3) To compare mortality among vinyl chloride workers with the mortality of other groups which TCA, Inc. has studied.

The study took the form of a historical prospective mortality study. e study population consisted of individuals who had worked for at least e year in a job involving exposure to vinyl chloride before December 31, 1972, d included retired and terminated as well as active workers. For each such rker the date of birth and an employment history were obtained, and the tal status of the worker as of December 31, 1972, was ascertained. For one found to have died, those death certificates that were available re obtained and the cause of death determined. The observed mortality s compared with that of the United States male population.

II. SELECTION OF STUDY PLANTS

The Manufacturing Chemists Association identified 43 United States plants belonging to 19 companies, which either produced vinyl chloride or used it in the production of polyvinyl chloride. The name and address of a responsible liaison person at each company and plant was provided to TCA, Inc. (Attachment A).

A brief questionnaire was sent to each plant to obtain an estimate of the exposed population and to find out how far back in time personnel records could be obtained, and to determine whether job histories were available for retired and terminated workers (Attachment B).

All the plants responded. On the basis of the replies, four plants were dropped from the study because they had begun operation after 1968. It was felt that exposures in such plants would be too recent and too brief to provide useful data. Study of one other plant was deferred because it had stopped production of vinyl chloride seven years ago, and appeared to present difficulties in identifying an exposed population.

In addition, three more plants were excluded from analysis because, when data analysis began, it was found that information from these plants was defective in one of several respects (e.g., no exposure data, no job histories available for terminated employees, etc.).

The present report therefore deals with 35 domestic plants involved in either VCM or PVC production, which provided a study population of 3884 individuals.

IV. DATA COLLECTION

In each plant, data were collected for each worker stated by the plant management to have been employed for at least one year in a job involving exposure to vinyl chloride. In some plants, particularly those producing the monomer, this determination could be made on the basis of job titles. Usually, however, exposure was a function of both job title and the location of the job in the plant, so that the assessment of exposure had to be made on a case-by-case basis by plant officials.

Data were collected for as far back in time as complete records were kept. In most cases this covered the entire history of the plant. In others, records were kept for a fixed period such as a decade. In a few, records were kept for different periods, depending on whether the worker had died on the job or had left employment.

In the latter case it was necessary to exercise care in defining the period for which study data were to be collected. For example, if a plant kept records for five years on those who left employment, but kept them indefinitely for those who died on the job, no termination could be included in the study unless it occurred within the last five years. Data from the earlier period would be biased for the purpose of this study, since a worker had to die to be in the records for the earlier period. The policy therefore was to determine how long each kind of record was kept (quit, discharged, retired and alive, retired and deceased, died while employed) and to define the study period as the shortest of these.

One problem which arose in the PVC plants resulted from the fact that a worker could transfer within the plant from exposed to non-exposed jobs. Therefore, even though the number of workers in exposed jobs at a given

one may have been a small proportion of the total work force, it was necessary to search every worker's record to find those who might in the past have had over a year's experience in exposed jobs. Several of the PVC plants undertook to conduct this search themselves.

As a result, plant data were collected in two ways. In some plants, a TCA, Inc., team visited the establishment, copied the records designated by management as representing exposed workers, and obtained sufficiently detailed exposure estimates to produce a job history. In others, the plants were provided by TCA, Inc. with standard forms which they filled out for workers whom they identified as exposed. Three basic forms were used, depending on whether the worker was known to be alive, known to be dead, or was of unknown status. In all three cases a work history with estimated exposure was recorded, the differences being in the ancillary data required. Attachment C shows such a form for workers known to be dead.

Approximately 5000 of the study population came from plants visited by TCA, Inc., while the remainder came from plants which had filled out the forms themselves.

V. THE MEASUREMENT OF EXPOSURE

The job history forms (Attachment C) were originally designed in the expectation that vinyl chloride exposure on each job could be quantified in parts per million. This proved generally to be impossible. However, industrial hygiene and safety personnel in each plant were able to identity certain jobs and locations as involving the highest exposures in the plant, and to classify other exposures as medium or low relative to the "high" presented by the jobs with the greatest exposure. Therefore, the attempt

to obtain objective exposure data was abandoned, and each exposed job in the worker's history was scored 1, 2, or 3 to indicate low, medium or high estimated exposure.

This gross classification has two major failings, as a result of the subjective nature of the estimates. The first is that the scores represent estimated relative exposure within a given plant. It is therefore possible that, in objective terms, a "high" score in one plant corresponds to a "medium" or even "low" score in another. The second is that exposures in most plants have tended to decrease over time, so that a worker with long service may have had jobs in the remote past which involved "low" exposure relative to other jobs at that time, but which might be "high" in comparison with current exposures in the same job. This subjective classification is therefore of questionable validity in characterizing the exposure of a given worker. For epidemiological purposes, however, those who have high scores can reasonably be expected, on the average, to have had the greatest exposure, while those with low scores will have had the least, even though the true exposure in each group may vary considerably from person to person.

The estimated exposure history of each worker was summarized by calculating An Exposure Index (EI). This was done by multiplying the number of months on each job by the exposure score, totalling these overall exposed jobs, and dividing by the total number of months of exposure.

VI. FOLLOW-UP OF STUDY POPULATION

A follow-up procedure was instituted for those who had left employment and whose vital status could not be determined at the local plant. A portion of the terminations was traced by mail, using a form letter sent to the last

known address. Attachment D shows such a letter. If the letter was returned as undeliverable, the procedure shown in Figure 1 was used to obtain a current address.

The remainder of the terminations was traced through a retail credit bureau. The latter was also done for a portion of those who could not be found by the mail follow-up.

Approximately 5500 of the study population came from plants in which direct mail follow up was employed. In the remainder of the population follow-ups was by retail credit bureau. There was no significant difference between the success rates of the two methodologies.

Table 1 shows the vital status of the study population as of December 31, 1972. Follow-up is 85 percent complete, although follow-up data were still being received at the time the files were closed for this report. Of the 352 workers known to be dead, death certificates have been received for all but 24.

The mortality calculations in the succeeding sections of this report are based only on those workers who were successfully traced, which is equivalent to assuming that mortality among those not found is the same as among those who were found. In order to examine the reasonableness of this assumption, the differences between those found and not found are examined briefly as part of the following section.

I. DESCRIPTION OF STUDY POPULATION

Table 2 shows the distribution of those successfully traced, by year of birth and number of months of exposure. The median birth year was 1931 (compared with 1920 for those not found) and the median duration of employment in an exposed job was 80 months (44 months in those not found). The

shortest exposures occur in both the oldest men, most of whose working life was over when vinyl chloride came into general use, and the youngest men, whose date of hire was closer to the closing date of the study.

Although nearly half of the study population had less than 60 months of exposed employment, there were nevertheless 855 workers with 20 years or more exposure, and 1641 with 15 years or more.

Table 3 shows the distribution by duration of exposure and the year in which exposure began. The median year in which exposure began was 1962 (versus 1953 for those not found). Notice that almost half the study population first entered exposed employment in the decade 1960-69. This reflects the fact that a great many plants first began vinyl chloride operations in that decade and means that these workers have not been followed for any substantial length of time after their exposure occurred.

Table 4 shows the relationship between duration of exposure and Exposure Index (EI). The median EI is 1.44 (1.75 for those not found). There does not appear to be a close relationship between the EI and the duration of exposure, that is, workers with a higher EI do not differ substantially in duration of exposure from those with a lower EI. One implication is that in assessing the relationship between mortality and exposure, both duration and level of exposure should be examined separately, as well as in combination.

The data shown above for those not found indicates that they were born (and began their exposure) about 10 years before the group on which follow-up was complete, and had about half the duration of employment with a slightly higher EI. Typically, their employment in an exposed job ended before 1960. The bulk of these workers came from older plants from

which data were collected late in the study.

Although there appears to be nothing very unusual about this group in terms of work history and exposure, it is nevertheless true that their exposures took place further back in time than that of the group successfully traced. It is therefore possible that their mortality, after a substantial latent period, might show a somewhat different pattern of mortality from the traced group.

VIII. CALCULATION OF RISK OF DEATH

The usual method of describing the risk of death in a study of this kind is to express the number of deaths which actually occurred as a percentage of the number which would have been expected in a comparable male population observed over the same age and time intervals. This statistic is called the Standardized Mortality Ratio (SMR).

In order to calculate the number of expected deaths it is first necessary to calculate the number of years for which each worker was observed, and to classify these years of observation by the age intervals into which they fell and the birth date of the worker.

Table 5 shows such a calculation for the 7128 vinyl chloride workers in whom follow-up was complete. This group represents 77,846 person-years of observation. For example, the table shows that for workers born in the years 1925-29, there were 2725 person-years of observation in the age interval 30-34, and an easy calculation shows that these person-years were observed in a period whose midpoint was about 1960. Therefore, the number of deaths to be expected in this cell of the table is the number of deaths occurring in 1960 among 2725 males aged 30-34 in a comparable non-exposed population.

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In the present study the U. S. male population was used as the standard of comparison, and the age-specific U. S. male death rates for the appropriate ages and years were applied to the corresponding cells of Table 5 to obtain the expected deaths.[1] This was done for all causes of death together, and for each of the 35 causes for which detailed mortality rates are published on a national basis (omitting such causes as breast cancer, congenital malformations, and diseases of infancy).

Table 6 shows observed and expected deaths, and the SMR, for each of these causes for the total study group. In calculating the SMR's for specific causes, the 24 deaths for which no certificates were found were assumed to have the same cause distribution as those for which certificates were available.

In the standard population, each SMR would be equal to 100. Therefore, the statistical significance of the deviation of each SMR in the study population from the expected value of 100 was tested. A single asterisk indicates those SMR's which differed significantly from 100 at the 5 percent level, that is, which had a probability of .05 or less of occurring by chance. A double asterisk indicates those which were significant at the 1 percent level. SMR's based on fewer than 5 observed cases were not tested for significance.[2] The practical interpretation of these statistical statements will be examined below.

Each diagonal in Table 5 corresponds to experience centered around a given year. For the first three diagonals (from left to right) 1950 rates were used; for the next three, 1955, 1959 and 1965 rates were used; for the last two, 1967 rates were used.

Large-sample tests of significance were derived from: Chiang, C. L., "Standard error of the age-adjusted death rate," Vital Statistics Special Reports, 47 (1961) pp 275-285.

Table 7 shows the same SMR's for workers with an Exposure Index below 1.5 versus those at 1.5 or above. The dividing point of 1.5 represents a level halfway between "low" and "medium."

Table 8 shows similar results for workers with less than 5 years exposure versus those with 5 years or more.

In order to examine the possible interaction between duration and level of exposure, the study population was divided into 4 groups on the basis of both EI (low vs high) and duration of exposure (short vs long) using the same dichotomization as Tables 7 and 8.

Table 9 shows the results for short versus long exposure in the low EI group, and Table 10 shows the same comparison in the high EI group.

In each of the above tables, deaths for which certificates had not been received were assumed to be distributed as a uniform percentage of causes. The cause specific SMR's were therefore adjusted upward by percentage which varied in each subgroup. Table II shows the distribution of uncertified deaths in each group, and the resulting percentage by which the cause specific SMR's were increased.

IX. ANALYSIS

The overall mortality of the study population is statistically significantly lower than that of the U. S. male population. There were 352 observed deaths compared with 467 expected, for an SMR of 75.

Table 6 shows that no specific cause of death was statistically significantly greater than expected. Several, particularly heart disease, accidents and "other diseases" not detailed in the tables, were significantly below their expected values.

When the study population is divided according to length and duration of exposure (Tables 7 and 8) and combinations of these measurements (Tables 9 and 10) three major patterns emerge.

For malignant neoplasms as a whole, the SMR increases with increasing exposure, whether measured by level, duration, or both. In the high exposure group with 5 years or more exposure (Table 10) there are 36 observed cases and 26.11 expected.

For cardiovascular - renal diseases as a group, there are also increases in the SMR with increasing exposure, but the number of observed cases remain less than expected, the differences being statistically significant in all groups except the high exposure, long duration group in Table 11.

For all other causes, there are no consistent relationships with exposure.

Within the malignant neoplasms, the largest (although not statistically) significant SMR is in cancers of the buccal cavity and pharynx, with 5 observed, 2.84 expected, and an SMR of 189. However, Tables 7 to 10 show that all these cases have Exposure Indexes below 1.5, and 4 out of the 5 have less than 5 years exposure.

Cancer of the digestive system shows no excess in the study population as a whole. However, in those workers with Exposure Indexes of 1.5 or higher, there are 12 observed cases where 9.14 are expected (table 7). In the subgroup of the above workers with 5 years or more exposure, there are 11 observed cases and 7.47 expected.

Respiratory cancer shows a slight excess in the total group, and a similar pattern for different exposure categories, with 13 observed versus 10.28 expected when the Exposure Index is 1.5 or higher, and 12 observed versus 8.50 expected when, in addition, the duration of exposure is 5 years

more.

Malignant neoplasms of other and unspecified sites show an excess in the total group, and an increase with both level and duration of exposure (Tables 7 and 8). The relationship with exposure is more pronounced, since those with exposures of less than 5 years have fewer cases than expected.

The lymphosarcomas, although occurring at about the expected rate when the whole group is considered, are concentrated almost entirely in the high exposure long duration group. In that category there are 4 cases observed and 1.84 expected.

Cancers of the genital and urinary organs, and leukemia, have fewer cases than expected. The number of cases is too small to examine any trends.

X. DISCUSSION

The favorable overall mortality of the study population is a phenomenon commonly observed in working populations. Studies of several occupational groups have shown that, even if there is an occupational hazard which greatly increases the risk of death from a particular cause, the overall mortality may well be favorable. Table 12 shows the SMR's obtained in a number of recent studies of other occupational groups. Although for technical reasons these SMR's are not strictly comparable, the overall mortality in the present study is clearly favorable.

SMR's which are higher than expected may be worthy of attention even if they are not statistically significant. This is especially true in the present study since the number of deaths from many causes is quite small, and even a relatively high SMR may not reach statistical significance.

If, in addition, a particular cause shows a consistent pattern of increase with exposure or estimated exposure, the findings are particularly

interesting.

By these criteria, mortality from digestive cancer, respiratory cancer, cancer of other and unspecified sites, and lymphosarcoma, appear to be related to exposure as estimated in this study.

In view of the association between vinyl chloride exposure and angiosarcoma of the liver, the digestive cancers were examined further to see what contribution angiosarcoma made to the observed mortality pattern.

Of the 19 digestive cancers, 7 were liver cancers, of which two were angiosarcomas according to the death certificate. However, among angiosarcoma deaths in vinyl chloride workers identified by other investigators, there were 6 which occurred in the present study population during the study period. They were all found in the course of the study, but 4 were listed on the death certificate as due to causes other than angiosarcoma. Table 13 shows these deaths with the death certificate cause.

If there had been no angiosarcomas, Table 13 shows that the total number of digestive cancers in the high exposure group would have dropped to 8, and the number with high exposure and 5 years or more exposure would have dropped to 2, so that the mortality pattern in this cause group is due entirely to angiosarcoma.

The other cause group worth further investigation is cancer of other and unspecified sites, both because it is a heterogeneous category and because it seems, unlike the other cancers, to be more related to duration than to level of exposures.

Table 14 shows a list of the specific causes included in this category, which is essentially brain cancer and generalized cancer with primary site

unknown. About 40 percent of the observed deaths were due to brain cancer. In the general male population, about 22 percent of this category is due to brain cancer, so that not only is the mortality from this cause excessive, but brain cancer is overrepresented.

The possibility exists based on the lack of specificity of some of the listed causes that some of the brain cancers were not primary, but metastases from another unidentified site such as the lung.

The cancers of the buccal cavity and pharynx are difficult to explain because of their occurrence in the low exposure - short exposure group. It is possible that this is a chance occurrence, or that exposures to other substances were involved.

XI. POSSIBLE BIASES IN THE CALCULATION OF RISK

There are three areas in which bias could have entered the calculation of the above SMR's. The first is the choice of the U. S. male population as a standard. The second is the absence of 15 percent of the population who were not found. The third is the discovery, as the study ended, of a group of 1500 workers whose exposures occurred up to 35 years ago, and who are not included in the study group.

The choice of the U. S. male population was not entirely appropriate. The study population was concentrated almost entirely in the Eastern half of the United States, whose normal mortality is slightly higher than that of the whole country. This implies that the correct expected values should have been slightly higher than the ones which were used, and the corresponding SMR's slightly lower. This has no practical significance except for those malignancies in which the SMR's were above 100. However, regional differences in mortality from those causes is such that these SMR's would have been at most 1.5 to 3 percent lower, with no substantive difference in the results.

The workers who could not be traced may conceivably contain a disproportionate number of deaths, which could increase the overall SMR. It appears unlikely that the distribution of causes would be substantially different. However, without actual data in hand, the possibility cannot be ruled out that either some new causes of death might become significant, or that some of the relationships found in this study might be diluted.

The same comments apply even more to the group of 1500 workers discovered too late to be included in the study group, since they would provide data in precisely the area (very long exposure and long latency) in which the present study is relatively weak.

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Table 1

Follow-up Status of 8384 Vinyl Chloride Workers

	Total	Alive	Dead	Unknown	Death Certificates	
					Rec'd.	Not Rec'd.
Number	8384	6776	352	1256	328	24
Percent	100.0	80.8	4.2	15.0	92.7	7.3

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Table 2

Distribution of Months in Exposed Employment by Birth Year, for 7128 Vinyl Chloride Workers with Completed Follow-up

Year of birth	Total	Months of exposure							
		<60	60-119	120-179	180-239	240-299	300-359	360-419	Unknown
1875-79	1	1							
1880-84	5		2	2	1				
1885-89	7	1	3	3					
1890-94	21	3	7	9	2				
1895-99	38	10	4	9	12	2			1
1900-04	89	9	13	21	22	17	6		1
1905-09	214	33	27	35	37	43	34	3	2
1910-14	404	79	62	58	72	73	43	15	2
1915-19	648	145	96	80	120	105	84	13	5
1920-24	897	229	191	98	143	160	64	8	4
1925-29	940	276	214	118	169	139	20		4
1930-34	877	287	252	128	181	26			3
1935-39	986	454	378	120	27				7
1940-44	1169	664	481	16					8
1945-49	700	632	66						2
1950-54	132	132							
Total	7128	2955	1796	697	786	565	25	39	39

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Table

Distribution of Months in Exposed Employment by Year
in Which Exposure Began, for 7128 Vinyl Chloride Workers with Completed Follow-up

Year Exp. Started	Total	Months of Exposure							
		<60	60-119	120-179	180-239	240-299	300-359	360-419	Unknown
1930-39	35	2	4	1	4	6	13	5	
1940-49	1048	135	93	119	151	277	237	34	2
1950-59	1962	389	257	383	631	282			20
1960-69	3368	1714	1442	195					17
1970-71	715	715							
Total	7128	2955	1796	698	786	565	250	39	39

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Tab

Distribution by Months of Exposed Employment and
Exposure Index
for 7128 Vinyl Chloride Workers with Complete Follow-up

Exposure Index	Total	Months of exposure							
		<60	60-119	120-179	180-239	240-299	300-359	360-419	Unknown
1.0-1.4	4032	1715	1125	402	406	274	92	18	
1.5+	3057	1240	671	295	380	291	159	21	
Unknown	39								39
Total	7128	2955	1796	697	786	565	251	39	39

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Table 5

Person Years of Observation by Year of Birth and Age for Vinyl Chloride Workers

Age	Totals	Year of Birth															
		1875 1879	1880 1884	1885 1889	1890 1894	1895 1899	1900 1904	1905 1909	1910 1914	1915 1919	1920 1924	1925 1929	1930 1934	1935 1939	1940 1944	1945 1949	1950 1954
Total	77846	13	92	124	317	705	1662	4055	6710	11038	14305	13807	9408	7239	6174	2022	174
15-19	134										1	11	12	5	53	21	31
20-24	4070									36	160	574	[illegible]	475	[illegible]	[illegible]	143
25-29	12076								32	335	[illegible]	1882	[illegible]	[illegible]	[illegible]	221	
30-34	13861							14	264	1054	2183	2725	2863	1779	[illegible]		
35-39	13550						3	221	697	1885	2742	3589	3776	306			
40-44	12031					5	70	524	1025	2044	2502	4113	745				
45-49	9527					56	241	710	1245	2631	3847	816					
50-54	6368				35	135	334	782	1574	2783	760						
55-59	3632			22	88	155	353	886	1626	432							
60-64	1684		14	35	77	142	341	822	253								
65-69	632	2	25	31	62	126	270	116									
70-74	202	5	23	20	43	71	40										
75-79	58	5	15	11	12	15											
80-84	16	1	10	5													
85-89	5		5														

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Cause of death with I.C.D. number	obs/exp	SMR[1]
All causes	352/467.28	75**
Tuberculosis (001-019)	1/5.71	19
Tuberculosis of respiratory system (001-008)	1/5.34	20
Malignant neoplasms (140-205)	79/77.16	110
Malignant neoplasms, buccal cavity and pharynx (140-148)	5/2.64	189
Malignant neoplasms, digestive organs and peritoneum (150-159)	19/21.67	94
Malignant neoplasms, respiratory system (160-164)	25/23.93	112
Malignant neoplasms, genital organs (170-179)	3/3.55	91
Malignant neoplasms, urinary organs (180-181)	1/3.60	30
Malignant neoplasms, other and unspecified sites (190-199)	17/11.75	155
Leukemia and aleukemia (204)	3/3.77	85
Lymphosarcoma, lymphatic and hematopoietic tissues (200-203, 205)	6/6.06	106
Diabetes mellitus (260)	7/6.31	120
Major cardiovascular and renal diseases (330-334, 400-468, 592-594)	155/207.46	80**
Vascular lesions affecting CNS (330-334)	13/24.48	57**
Rheumatic fever & chronic rheumatic heart dis. (400-402, 410-416)	5/6.87	78
Arteriosclerotic heart disease (420)	121/137.33	95
Nonrheumatic endocarditis (421, 422)	1/6.53	16
Hypertensive heart disease (440-443)	3/9.33	35
Other hypertensive disease (444-447)	3/2.60	124
Chronic & unspecified nephritis & renal sclerosis (592-594)	0/4.27	0
Influenza and pneumonia (480-493)	5/9.96	54*
Ulcer of stomach and duodenum (540,541)	2/3.83	56
Appendicitis (550-553)	0/0.66	0
Hernia and intestinal obstruction (560, 561, 570)	1/1.51	71
Gastritis, duodenitis, enteritis and colitis (543, 571, 572)	1/1.31	82
Cirrhosis of liver (581)	3/15.60	21
Hyperplasia of prostate (610)	0/0.39	0
Symptoms, senility and ill-defined conditions (780-795)	1/7.34	15
All other diseases (residual)	21/45.78	49**
Motor vehicle accidents (810-835)	17/32.70	58**
Other accidents (800-802, 840-962)	13/20.64	63**
Suicide (963, 970-979)	16/16.83	102
Homicide (964, 980-985)	1/11.98	9
Number of workers	7128	
Person-years	77846	

[1]SMR's adjusted for deaths with cause unknown. See Table 11.
*Significant at 5% level.
**Significant at 1% level.

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Cause of death with I.C.D. number	EI <1.5 obs/exp	EI <1.5 SMR[1]	EI ≥1.5 obs/exp	EI ≥1.5 SMR[1]
All causes	188/270.33	70**	157/195.68	80**
Tuberculosis (001-019)	0/3.38	0	0/2.33	0
Tuberculosis of respiratory system (001-008)	0/3.16	0	0/2.18	0
Malignant neoplasms (140-205)	37/44.28	90	41/32.67	134
Malignant neoplasms, buccal cavity and pharynx (140-149)	5/1.62	330	0/1.21	0
Malignant neoplasms, digestive organs and peritoneum (150-159)	7/12.50	60*	12/9.14	141
Malignant neoplasms, respiratory system (160-164)	11/13.56	86	13/10.28	135
Malignant neoplasms, genital organs (170-179)	2/2.30	93	1/1.43	75
Malignant neoplasms, urinary organs (180-181)	1/2.07	51	0/1.52	0
Malignant neoplasms, other and unspecified sites (190-199)	9/6.57	146	8/4.52	190
Leukemia and aleukemia (204)	1/2.18	49	2/1.57	136
Lymphosarcoma, lymphatic and hematopoietic tissues (200-203, 205)	1/3.48	31	5/2.54	212
Diabetes mellitus (260)	5/3.65	146	2/2.65	81
Major cardiovascular and renal diseases (330-334, 400-468, 592-594)	84/120.11	75**	69/86.89	85*
Vascular lesions affecting CNS (330-334)	7/14.42	52**	6/10.06	64
Rheumatic fever & chronic rheumatic heart dis. (400-402, 410-416)	3/3.98	80	2/2.85	75
Arteriosclerotic heart disease (420)	68/78.94	92	51/58.05	95
Nonrheumatic endocarditis (421, 422)	0/4.20	0	1/3.89	38
Hypertensive heart disease (440-443)	1/5.48	19	2/3.86	56
Other hypertensive disease (444-447)	1/1.52	70	2/1.07	201
Chronic & unspecified nephritis & renal sclerosis (592-594)	0/2.50	0	0/1.77	0
Influenza and pneumonia (480-493)	5/5.50	92	0/4.13	0
Ulcer of stomach and duodenum (540, 541)	1/2.21	48	1/1.60	68
Appendicitis (550-553)	0/0.39	0	0/0.27	0
Hernia and intestinal obstruction (560, 561, 570)	0/0.83	0	1/0.63	171
Gastritis, duodenitis, enteritis and colitis (543, 571, 572)	0/0.76	0	1/0.55	196
Cirrhosis of liver (581)	2/8.90	23	1/6.64	16
Hyperplasia of prostate (610)	0/0.25	0	0/0.14	0
Symptoms, senility and ill-defined conditions (780-795)	0/4.22	0	1/3.09	34
All other diseases (residual)	14/21.90	68*	6/15.89	41**
Motor vehicle accidents (810-835)	8/19.08	45**	9/13.46	72
Other accidents (800-802, 840-962)	11/17.83	66*	8/12.67	50**
Suicide (963, 970-979)	9/9.73	93	7/7.02	107
Homicide (964, 980-985)	0/6.98	0	1/4.94	21
Number of workers	4032		3057	
Person-years	43354		32108	

[1]SMR's adjusted for deaths with cause unknown. See Table 11.

*Significant at 5% level.

**Significant at 1% level.

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Cause of death with I.C.D. number	<60 months obs/exp	<60 months SMR[1]	≥60 months obs/exp	≥60 months SMR[1]
All causes	94/140.53	67**	251/329.30	76**
Tuberculosis (001-019)	0/2.23	0	0/3.55	0
Tuberculosis of respiratory system (001-008)	0/2.07	0	0/3.33	0
Malignant neoplasms (140-205)	13/19.96	78	65/57.61	116
Malignant neoplasms, buccal cavity and pharynx (140-148)	4/0.70	688	1/2.16	47
Malignant neoplasms, digestive organs and peritoneum (150-159)	2/5.26	46	17/16.56	106
Malignant neoplasms, respiratory system (160-164)	3/5.52	65	21/18.51	116
Malignant neoplasms, genital organs (170-179)	0/0.99	0	3/2.76	112
Malignant neoplasms, urinary organs (180-181)	0/0.83	0	1/2.79	37
Malignant neoplasms, other and unspecified sites (190-199)	2/3.40	71	15/8.23	187
Leukemia and aleukemia (204)	1/1.25	96	2/2.53	81
Lymphosarcoma, lymphatic and hematopoietic tissues (200-203, 205)	1/2.01	60	5/4.07	126
Diabetes mellitus (260)	2/1.80	134	5/4.54	113
Major cardiovascular and renal diseases (320-334, 400-468, 592-594)	28/51.45	65**	125/157.09	81**
Vascular lesions affecting CNS (330-334)	4/5.97	81	9/18.71	49**
Rheumatic fever & chronic rheumatic heart dis. (400-402, 410-416)	2/2.38	101	3/4.53	68
Arteriosclerotic heart disease (420)	21/32.54	79*	98/105.39	96
Nonrheumatic endocarditis (421, 422)	0/1.79	0	1/5.35	20
Hypertensive heart disease (440-443)	1/2.42	49	2/7.01	30
Other hypertensive disease (444-447)	0/0.79	0	3/1.82	170
Chronic & unspecified nephritis & renal sclerosis (592-594)	0/1.55	0	0/2.76	0
Influenza and pneumonia (480-493)	3/2.93	123	2/7.09	29
Ulcer of stomach and duodenum (540,541)	1/1.07	112	1/2.78	37
Appendicitis (550-553)	0/0.24	0	0/0.43	0
Hernia and intestinal obstruction (560, 561, 570)	0/0.42	0	1/1.10	93
Gastritis, duodenitis, enteritis and colitis (543, 571, 572)	1/0.40	301	0/0.92	0
Cirrhosis of liver (581)	1/4.49	26	2/11.18	18
Hyperplasia of prostate (610)	0/0.07	0	0/0.33	0
Symptoms, senility and ill-defined conditions (780-795)	1/2.28	53	0/5.09	0
All other diseases (residual)	4/11.97	40	16/26.34	63*
Motor vehicle accidents (810-835)	10/16.14	75	7/16.65	43**
Other accidents' (800-802, 840-962)	7/12.94	65*	10/17.82	58*
Suicide (963, 970-979)	6/5.34	114	10/10.28	100
Homicide (964, 980-985)	1/5.80	20	0/6.20	0
Number of workers	2955		4134	
Person-years	34201		43740	

[1]SMR's adjusted for deaths with cause unknown. See [illegible] 11.
*Significant at 5% level.
**Significant at 1% level.

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WITH EXPOSURE INDICES BELOW 1.5, BY DURATION OF EXPOSED EMPLOYMENT

Cause of death with I.C.D. number	<60 months exposure obs/exp	<60 months exposure SMR[1]	≥60 months exposure obs/exp	≥60 months exposure SMR[1]
All causes	55/89.23	63**	132/181.28	73**
Tuberculosis (001-019)	0/1.41	0	0/1.37	0
Tuberculosis of respiratory system (001-008)	0/1.31	0	0/1.35	0
Malignant neoplasms (140-205)	8/12.86	73	29/31.46	95
Malignant neoplasms, buccal cavity and pharynx (140-148)	4/0.45	1036	1/1.17	88
Malignant neoplasms, digestive organs and peritoneum (150-159)	1/3.43	34	6/9.08	68
Malignant neoplasms, respiratory system (160-164)	2/3.58	65	9/10.00	93
Malignant neoplasms, genital organs (170-179)	0/0.68	0	2/1.62	127
Malignant neoplasms, urinary organs (180-181)	0/0.55	0	1/1.53	67
Malignant neoplasms, other and unspecified sites (190-199)	1/0.97	120	8/4.43	187
Leukemia and aleukemia (204)	0/0.79	0	1/1.40	73
Lymphosarcoma, lymphatic and hematopoietic tissues (200-203,205)	0/1.26	0	1/2.23	46
Diabetes mellitus (260)	2/1.15	203	3/2.50	124
Major cardiovascular and renal diseases (330-334, 400-468, 592-594)	21/33.38	73**	63/86.82	75**
Vascular lesions affecting CNS (330-334)	2/3.93	59	5/10.51	49*
Rheumatic fever & chronic rheumatic heart dis. (400-402, 410-416)	2/1.50	155	1/2.49	41
Arteriosclerotic heart disease (420)	16/21.14	88	52/57.87	93
Nonrheumatic endocarditis (421, 422)	0/1.18	0	0/3.02	0
Hypertensive heart disease (440-443)	1/1.58	74	0/3.90	0
Other hypertensive disease (444-447)	0/0.50	0	1/1.02	101
Chronic & unspecified nephritis & renal sclerosis (592-594)	0/0.97	0	0/1.53	0
Influenza and pneumonia (480-493)	3/1.86	188	2/3.95	53
Ulcer of stomach and duodenum (540, 541)	0/0.68	0	1/1.53	67
Appendicitis (550-553)	0/0.15	0	0/0.24	0
Hernia and intestinal obstruction (560, 561, 570)	0/0.27	0	0/0.61	0
Gastritis, duodenitis, enteritis and colitis (543, 571, 572)	0/0.26	0	0/0.51	0
Cirrhosis of liver (581)	1/2.80	42	1/6.09	16
Hyperplasia of prostate (610)	0/0.05	0	0/0.20	0
Symptoms, senility and ill-defined conditions (780-795)	0/1.43	0	0/2.79	0
All other diseases (residual)	4/7.45	63	10/12.92	79
Motor vehicle accidents (810-835)	3/9.87	35	5/9.22	56
Other accidents (800-802, 840-962)	3/7.88	44	8/9.85	83
Suicide (963, 970-979)	3/4.08	86	6/5.66	109
Homicide (964, 980-985)	0/2.85	0	0/3.43	0
Number of workers	1715		2317	
Person-years	21418		23920	

[1]SMR's adjusted for deaths with cause unknown. See table 11.
*Significant at 5% level.
**Significant at 1% level.

May 2, 1974

Cause of death with I.C.D. number	<60 months exposure obs/exp	<60 months exposure SMR[1]	≥60 months exposure obs/exp	≥60 months exposure SMR[1]
All causes	33/47.93	79	119/147.81	81*
Tuberculosis (001-019)	0/0.76	0	0/1.57	0
Tuberculosis of resporatory system (001-008)	0/0.71	0	0/1.48	0
Malignant neoplasms (140-205)	5/6.57	96	36/26.11	141
Malignant neoplasms, buccal cavity and pharynx (140-148)	0/0.23	0	0/0.99	0
Malignant neoplasms, digestive organs and peritoneum (150-159)	1/1.67	76	11/7.47	151
Malignant neoplasms, respiratory system (160-164)	1/1.79	71	12/8.50	144
Malignant neoplasms, genital organs (170-179)	0/0.29	0	1/1.41	73
Malignant neoplasms, urinary organs (180-181)	0/0.26	0	0/1.26	0
Malignant neoplasms, other and unspecified sites (190-199)	1/1.18	107	7/3.51	204
Leukemia and aleukemia (204)	1/0.44	288	1/1.13	90
Lymphosarcoma, lymphatic and hematopoietic tissues (200-203, 205)	1/0.71	178	4/1.84	222
Diabetes mellitus (260)	0/0.61	0	2/2.04	100
Major cardiovascular and renal diseases (330-334, 400-468, 592-594)	7/16.54	54**	62/70.46	90
Vascular lesions affecting CNS (330-334)	2/1.87	135	4/8.19	50
Rheumatic fever & chronic rheumatic heart dis. (400-402, 410-416)	0/0.82	0	2/2.04	100
Arteriosclerotic heart disease (420)	5/10.41	61*	46/47.65	98
Nonrheumatic endocarditis (421, 422)	0/0.57	0	1/2.32	44
Hypertensive heart disease (440-443)	0/0.76	0	2/3.10	66
Other hypertensive disease (444-447)	0/0.27	0	2/0.81	253
Chronic & unspecified nephritis & renal sclerosis (592-594)	0/0.54	0	0/1.23	0
Influenza and pneumonia (480-493)	0/0.99	0	0/3.13	0
Ulcer of stomach and duodenum (540, 541)	1/0.35	362	0/1.25	0
Appendicitis (550-553)	0/0.08	0	0/0.19	0
Hernia and intestinal obstruction (560, 561, 570)	0/0.14	0	1/0.49	209
Gastritis, duodenitis, enteritis and colitis (543, 571, 572)	1/0.14	904	0/0.41	0
Cirrhosis of liver (581)	0/1.56	0	1/5.03	20
Hyperplasia of prostate (610)	0/0.01	0	0/0.13	0
Symptoms, senility and ill-defined conditions (780-795)	1/0.80	158	0/2.30	0
All other diseases (residual)	0/4.02	0	6/11.88	51*
Motor vehicle accidents (810-835)	7/6.05	146	2/7.43	28
Other accidents (800-802, 840-962)	4/4.73	107	2/7.96	26
Suicide (963, 970-979)	3/2.40	158	4/4.62	88
Homicide (964, 980-985)	1/2.18	56	0/2.76	0
Number of workers	1240		1817	
Person-years	12828		19305	

[1]SMR's adjusted for deaths with cause unknown. See Table 11.
*Significant at 5% level.
**Significant at 1% level.

May 2, 1974

Table 11

Distribution of Deaths by Exposure Category and by Whether Cause of Death Was Determined, and Correction Factors Used for SMR Calculations

	Total*	Exposure Categories							
		Exposure Index		Total Exposure Time in Months		Exposure Index and Total Exposure in Months			
		<1.5	≥1.5	<60	≥60	<1.5 & <60	<1.5 & ≥60	≥1.5 & <60	≥1.5 & ≥60
All causes	352	188	157	94	251	56	132	38	119
Cause known	328	176	146	78	244	48	128	30	116
Cause unknown	24	12	11	16	7	8	4	8	3
Percent increase in SMR's	7.3	6.8	7.5	20.5	2.8	16.6	3.1	26.6	2.5

*Deaths in exposure categories do not add up to deaths in total category because 7 deaths had unknown exposure data, and one of those was of unknown cause.

May 2, 1974

Table 12

Results of Follow-up in Several Occupational Groups

Study Population	Number Observed	Years of Observation	SMR All causes	Reference
Asbestos building product workers	12,402	1951-1963	89	Enterline & Kendrick, 1967
Asbestos friction material workers	7,510	"	89	Enterline & Kendrick, 1967
Asbestos textile plant workers	1,843	"	121	Enterline & Kendrick, 1967
Cotton textile workers	6,281	"	88	Enterline & Kendrick, 1967
White underground uranium miners	3,414	1950-1967	159	Lundin et al, 1969
Steelworkers	59,072	1953-1961	82	Lloyd & Ciocco, 1969
Asbestos insulation workers > 20 years	250	1946-1965	140	Tabershaw et al, 1970
Coke oven workers	4,661	1951-1966	98	Richmond et al, 1972
Asbestos maintenance service, etc.	438	1941-1969	124	Enterline et al, 1972
Asbestos insulation workers > 20 years	370	1963-1971	198	Hammond & Selikoff, 1972
Asbestos insulation workers	17,800	1967-1971	136	Hammond & Selikoff, 1972
Uranium mill workers	662	1950-1967	99	Archer et al, 1973
Lead smelter workers	2,352	1946-1970	107	TCA, Inc., unpublished
Lead battery plant workers	4,680	1946-1970	99	TCA, Inc., unpublished
Petroleum refinery workers	18,916	1962-1971	68	TCA, Inc., unpublished

May 3, 1974

4255	60	203	Cirrhosis of liver (sev. weeks)	yes
		281	Bleeding from hepatoma (3 days) (Laennecs cirrhosis)	yes
5765	45	167	Angiosarcoma rt. lobe of liver (10 mos.)	yes
7303	38	174	Liver failure (1 mo.) Cancer of liver, primary (15 mos.)	-
7376	52	238	Cardiac tamponade and massive left hemothorax (mins.) Widely metastatic angiosarcoma of liver (4 mos.)	-
7385	43	214	Hepatic failure Primary carcinoma liver	yes

April 15, 1974

Study No.	Age at Death	Mos. Exposed	Cause as Given	Autopsy
2744	38	186	Widespread metastatic melanoma (1 yr.) Malignant melanoma of back	yes
3700	48	50	Malignant melanoma with widespread metastases	no
2096	67	69	Brain tumor (carcinoma) (8 mos.)	-
3946	43	64	Meningitis and pneumonitis (5 wks.) Ependymoma, fourth ventricle-brain (2 mos. post-op craniotomy)	no
4433	54	81	Astrocytoma, malignant-left cerebral hemisphere (1 yr.)	yes
4800	61	51	Carcinoma of the brain Arteriosclerosis Pneumonia due to static congestion	no
7279	57	271	Brain tumor, glioblastoma multiforme (18 mos.)	-
7300	44	211	Brain tumor, malignant (2 mos.)	-
7371	58	249	Brain tumor, malignant	no
7306	53	216	Thyroid carcinoma with metastases	no
5769	52	239	Carcinomatosis Carcinoma vertebral body	yes

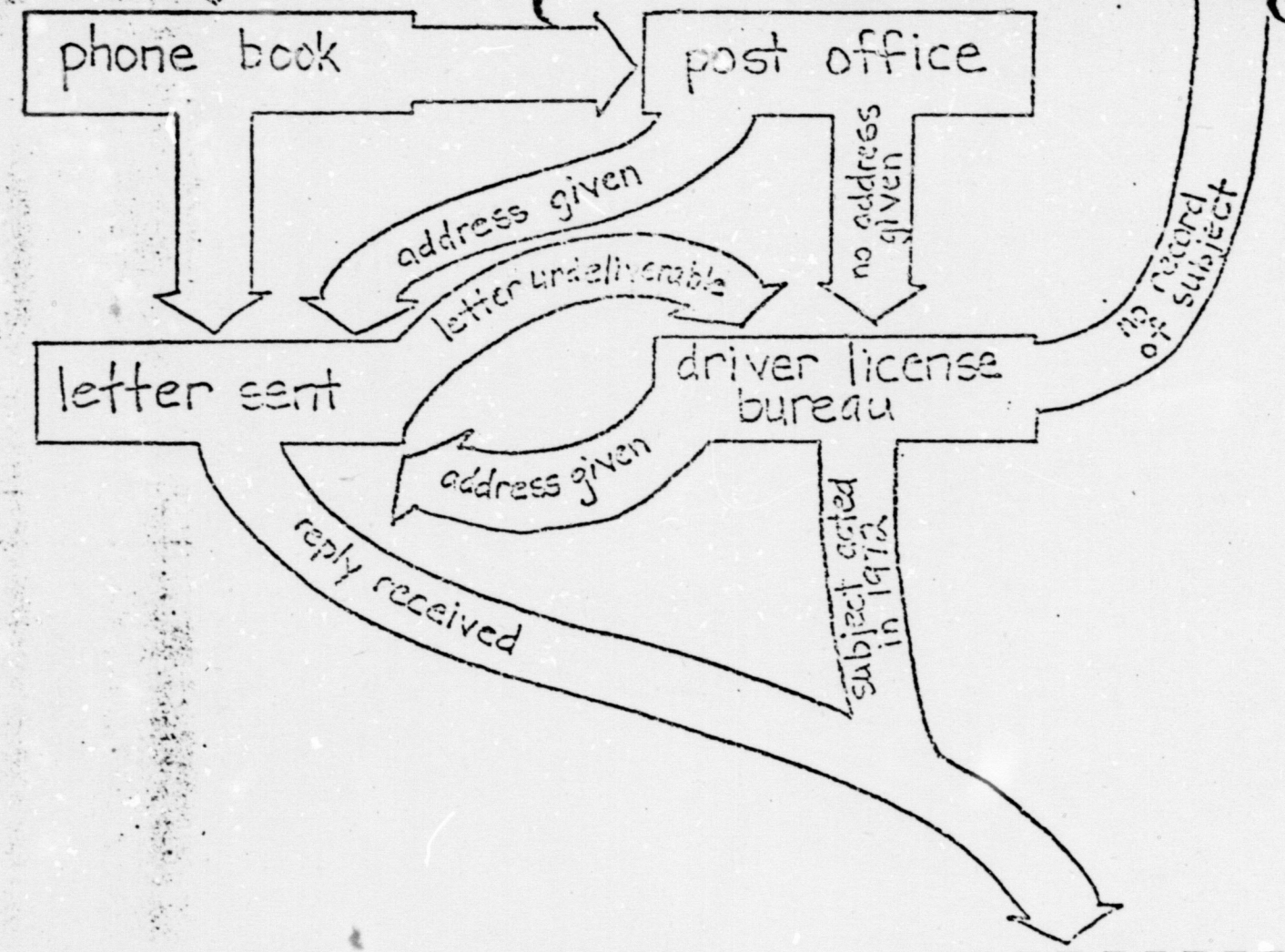
Other Malignancies (cont.)

Study No.	Age at Death	Mos. Exposed	Cause as Given	Autopsy
5246	67	201	Liposarcoma with metastasis (3 mos.)	yes
2850	64	193	Carcinomatosis, primary region not known (Past history, rheumatoid arthritis, myocardial infarction)	no
4778	54	300	Cardiac arrest (1 hr.) Respiratory arrest and cerebral hypoxia (2 days) Widespread metastatic carcinoma (2 mos.)	-
4786	61	318	Generalized metastasis undifferentiated (7 mos.) Squamous cell carcinoma, primary site undetermined	yes
5783	69	166	Metastatic carcinoma of abdomen Critical site undetermined (Pulmonary emphysema)	-
7301	55	133	Carcinomatosis (4 mos.) Primary site undetermined	no

April 15, 1974

Study No.	Age at Death	Mos. Exposed	Cause as Given	Autopsy
3003	31	49	Carcinoma of lip with metastasis to lung and neck (5 yrs.)	no
3431	56	30	Pulmonary edema (50 min.) Pulmonary metastases (Carcinoma, epidermoid, tongue and mandible)	no
3001	57	71	Metastatic squamous cell ca. - primary lesion palate	yes
7365	54	40	Atelectasis due to metastasis to mediastinum (4 mos.) Multiple malignant metastases to brain, liver & mediastinum (1 yr.) Adeno-carcinoma of nasal pharynx (2 yrs.)	yes
3354	63	26	Massive hemorrhage into tracheo-tree Status post laryngo-pharyngectomy, left radial neck dissection Well-differentiated keratinizing squamous cell carcinoma of left pyriform sinus (mos.)	yes

April 15, 1974



OLLOWUP

ITAL
TATUS
NOWN

ACTIVE EMPLOYEES

RETIREES

TERMINATIONS LOCATED

FIGURE 1

ent Corporation _____

lant Designation _____

ddress _____

_____

elephone ( ) - ext.

ERSHAW-COOPER ASSOCIATES' CONTACT FOR SUBJECT STUDY:

e _____

tle _____

ling Address _____

_____

eet Address (please identify with sufficient precision to serve as a taxi-driver's instruction)

_____

_____

phone ( ) _____

Signed _____

Name _____

Title _____

Company _____

Address _____

_____

Telephone ( ) ext.

bershaw-Cooper Associates, Inc.
180 Milvia St., Suite 104
erkeley, California 94704

anufacturing Chemists Association VCM Epidemiological Study

lant No.

When did this plant begin work involving vinyl chloride? _____

. What is the approximate size of the current work force, exclusive of secretarial and office personnel? _____

. Approximately how many of these are employed in jobs involving some exposure to vinyl chloride? _____

. Please answer the appropriate one of the following questions about your retirement plan.

a. No retirement plan _____

b. Voluntary plan, begun in _____

c. Required of all employees, begun in _____

d. Now required, formerly voluntary.
Voluntary plan begun in _____

Required plan begun in _____

Remarks: _____

_____

_____

Please answer the applicable questions below about retention of records. How long are personnel records kept

. for those who retired but were not covered by a retirement plan? _____

. for those who retired under a retirement plan and have died? _____

. for those who quit or were discharged? _____

. for those who died while employed? _____

ATTACHMENT B

6. Do the personnel records which are retained contain a record of job titles and dates of job title changes for the individual concerned? _____

7. Please list the job titles in the current work force which involve some exposure to vinyl chloride.

VCM Epidemiological Study - Individual Work History

Form B - Workers known to have died (please attach copy of death certificate)

1. Date of birth _____
2. Date hired _____
3. Date of death _____
4. Place of death _____

Status at time of death:
5. Employed _____
6. Retired (give date) _____
7. Terminated (give date) _____

8. If death certificate is not available, please give name of worker so that death certificate can be obtained. No contact will be made with relatives or attending physician.

_____

Job history with estimated exposure

Title		Check estimated exposure in ppm			
		<50	50-199	200-500	>500
_____	from _____				
	to _____				
_____	from _____				
	to _____				
_____	from _____				
	to _____				
_____	from _____				
	to _____				
_____	from _____				
	to _____				
_____	from _____				
	to _____				
_____	from _____				
	to _____				

ershaw/cooper associates inc.

...eet, Berkeley, California 94704. Telephone (415) 845-3355

Dear

We are a research firm concerned with the health of workers in industry in the United States. We have been asked to study certain occupations in order to determine the health of men who have at one time or another worked in these occupations.

To accomplish this we need to know if those men we are interested in were alive on December 31, 1972. For any of the men who died on or before that date, we need to know the place and date of death. With these facts, we can compare the health statistics of our men with the general population.

To assist us, can you provide information regarding the person whose name appears below? A stamped, addressed return envelope is enclosed for your reply.

...eedless to say, any information you give us is strictly confidential.

Thanks for your cooperation and assistance with this project.

Sincerely,

W. Clark Cooper, M.D.

Name: Date of birth:

Was above named man alive as of 12/31/72? _____

If deceased prior to 12/31/72:

Date of death _____

Place of death (city and state)

_____

_____

Ex 20 M

STATEMENT OF ROBERT D. SOULE
VICE-PRESIDENT, INDUSTRIAL HYGIENE SERVICES
FOR GEORGE D. CLAYTON AND ASSOCIATES
PREPARED FOR PRESENTATION AT
DEPARTMENT OF LABOR HEARINGS ON
VINYL CHLORIDE;
OCCUPATIONAL EXPOSURE STANDARD
JUNE 25, 1974

JUDGE MYATT:

MY NAME IS ROBERT D. SOULE OF 4221 MARYWOOD DRIVE, TROY, MICHIGAN. I AM CURRENTLY VICE-PRESIDENT, INDUSTRIAL HYGIENE SERVICES FOR GEORGE D. CLAYTON AND ASSOCIATES, AN ENVIRONMENTAL HEALTH CONSULTING ORGANIZATION LOCATED IN SOUTHFIELD, MICHIGAN WITH A BRANCH OFFICE IN FALLBROOK, CALIFORNIA.

I RECEIVED A BACHELOR OF SCIENCE DEGREE (CHEMICAL ENGINEERING) FROM MICHIGAN STATE UNIVERSITY IN 1963 AND A MASTER OF SCIENCE IN CHEMICAL ENGINEERING DEGREE FROM PURDUE UNIVERSITY IN 1965. BETWEEN FEBRUARY, 1965

AND JULY, 1970 I WAS EMPLOYED BY THE DOW CHEMICAL COMPANY. WITH THE EXCEPTION OF THE FIRST FOUR MONTHS, MY ACTIVITIES WHILE EMPLOYED BY THE DOW CHEMICAL COMPANY WERE IN THE FIELD OF INDUSTRIAL HYGIENE--FOUR AND ONE-HALF YEARS AS AN ENVIRONMENTAL HEALTH ENGINEER WITH THE CORPORATE ENVIRONMENTAL HEALTH LABORATORY AND ONE YEAR AS SENIOR INDUSTRIAL HYGIENIST WITH THE TEXAS DIVISION IN FREEPORT, TEXAS. SINCE JULY, 1970 I HAVE BEEN RESPONSIBLE FOR THE INDUSTRIAL HYGIENE SERVICES OF GEORGE D. CLAYTON AND ASSOCIATES, A PRIVATE INDEPENDENT CONSULTING FIRM ESTABLISHED IN 1954. IN MY PRESENT POSITION, I HAVE BEEN RESPONSIBLE FOR PROVIDING INDUSTRIAL HYGIENE CONSULTATIVE SERVICES TO A WIDE SPECTRUM OF INDUSTRIES, TO VARIOUS TRADE ASSOCIATIONS, TO INSURANCE COMPANIES, AND TO SEVERAL GOVERNMENTAL AGENCIES. I HAVE BEEN PERSONALLY INVOLVED IN SEVERAL CONTESTED CASES HEARD BEFORE THE OCCUPATIONAL SAFETY AND HEALTH REVIEW COMMISSION, BOTH AS AN EXPERT WITNESS FOR THE U. S. DEPARTMENT OF LABOR AND ON BEHALF OF INDUSTRIAL CLIENTS.

I AM A REGISTERED PROFESSIONAL ENGINEER IN THE STATES OF MICHIGAN, INDIANA AND TEXAS. I AM CERTIFIED IN THE COMPREHENSIVE PRACTICE OF INDUSTRIAL HYGIENE BY

THE AMERICAN BOARD OF INDUSTRIAL HYGIENE, CERTIFIED AS AN INDUSTRIAL HYGIENE ENGINEER BY THE ENVIRONMENTAL ENGINEERING INTERSOCIETY BOARD AND CERTIFIED BY THE BOARD OF CERTIFIED SAFETY PROFESSIONALS.

THE PURPOSE OF THIS PRESENTATION IS TO FOCUS ATTENTION ON THAT PORTION OF THE PROPOSED PERMANENT STANDARD FOR VINYL CHLORIDE WHICH PERTAINS TO REQUIREMENTS FOR USE OF PERSONAL RESPIRATORY DEVICES. THE PROPOSED PERMANENT STANDARD STATES IN PART "WHERE DETECTABLE LEVELS OF VINYL CHLORIDE ARE MEASURED, IMMEDIATE PROTECTION SHALL BE PROVIDED AGAINST EXPOSURE TO VINYL CHLORIDE BY THE USE OF ENGINEERING CONTROLS, WORK PRACTICE METHODS AND RESPIRATORS....

"WHEREVER FEASIBLE ENGINEERING CONTROLS AND WORK PRACTICE METHODS, WHICH CAN BE INSTITUTED IMMEDIATELY, ARE NOT SUFFICIENT TO REDUCE CONCENTRATIONS OF VINYL CHLORIDE BELOW THE DETECTABLE LEVEL THEY SHALL NONETHELESS BE USED TO REDUCE THE CONCENTRATIONS TO THE LOWEST PRACTICABLE LEVEL AND SHALL BE SUPPLEMENTED BY MEANS OF RESPIRATORS....

"WHEREVER NO FEASIBLE ENGINEERING CONTROL OR WORK PRACTICE METHOD CAN BE INSTITUTED IMMEDIATELY, IMMEDIATE RESPIRATORY PROTECTION SHALL BE PROVIDED...."

THE PARAGRAPH OF THE PROPOSED PERMANENT STANDARD WHICH DEALS SPECIFICALLY WITH RESPIRATORY PROTECTION (§1910.93Q(G)) STATES THAT "RESPIRATORS SHALL BE USED ONLY IN CASES OF EMERGENCY AND WHERE REQUIRED BY ANY OTHER PROVISION OF THIS SECTION. RESPIRATORS MAY NOT BE USED IN LIEU OF FEASIBLE ENGINEERING CONTROLS OR WORK PRACTICE METHODS." THIS PARAGRAPH OF THE PROPOSED STANDARD FURTHER SPECIFIES WHAT TYPES OF RESPIRATORS OR COMBINATION OF RESPIRATORS FOR PROTECTION AGAINST VINYL CHLORIDE MAY BE SELECTED. THESE INCLUDE: (A) A POSITIVE PRESSURE, FULL-FACE PIECE SELF-CONTAINED BREATHING APPARATUS, (B) A PRESSURE-DEMAND FULL-FACE PIECE SELF-CONTAINED BREATHING APPARATUS OPERATING IN THE PRESSURE-DEMAND MODE, (C) A COMBINATION TYPE "C" PRESSURE-DEMAND FULL-FACE PIECE RESPIRATOR OPERATING IN THE PRESSURE-DEMAND MODE AND A PRESSURE-DEMAND SELF-CONTAINED BREATHING APPARATUS OPERATING IN THE PRESSURE-DEMAND MODE, AND (D) A COMBINATION TYPE "C" CONTINUOUS FLOW RESPIRATOR AND PRESSURE-DEMAND SELF-CONTAINED BREATHING APPARATUS OPERATING IN THE PRESSURE-DEMAND MODE.

ON THE BASIS OF MY PAST AND PRESENT EMPLOYMENT WHICH HAS HAD ASSOCIATED WITH IT OCCASSIONS TO BECOME FAMILIAR WITH THE PRODUCTION OF VINYL CHLORIDE AND POLY-

VINYL CHLORIDE, I AM FAMI A GENERAL WAY WITH THE
NATURE OF THE DUTIES REQ PLANT PERSONNEL. MY
PRESENTATION TODAY TAKES OUNT MY UNDERSTANDING
OF THE ROUTINE ACTIVITIES D OF EMPLOYEES IN THESE
INDUSTRIES; AND IS DIREC AJOR PART, TO THE
CONSIDERATION OF THE FEA OF CONDUCTING PLANT
OPERATIONS WHILE THE EMPL R RESPIRATORS ON A
FULL-TIME BASIS.

THE TYPE OF PE SPIRATORY PROTECTIVE
DEVICE WHICH IS SELECTED MUST BE A DIRECT FUNCTION
OF THE NATURE AND EXTENT AZARD, THE CONDITIONS
OF THE WORK PLACE AND RE S FOR THE JOBS IN WHICH
THE WORKERS ARE ENGAGED. CHARACTERISTICS AND
LIMITATIONS OF THE RESPI AILABLE FOR USE. THERE
ARE BASICALLY THREE TYPE IRATORS WHICH ARE
AVAILABLE FOR USE IN ATMO CONTAINING VAPORS OF
ORGANIC SUBSTANCES IN GE D VINYL CHLORIDE IN
PARTICULAR. THESE INCLU LF-CONTAINED BREATHING
APPARATUS WHICH INCORPOR PLY OF AIR, OXYGEN OR
OXYGEN-GENERATING MATERIA IS ACTUALLY CARRIED BY
THE WEARER OF THE RESPIRA THE HOSE MASK AND
AIRLINE RESPIRATORS WHICH RATE A MECHANISM FOR

PROVIDING THE WEARER WITH A SOURCE OF FRESH AIR. THE BASIC DIFFERENCE BETWEEN THE HOSE MASK AND AIRLINE RESPIRATORS IS THAT WITH THE HOSE MASK RESPIRATOR, AIR IS SUPPLIED WITH OR WITHOUT MEANS OF A BLOWER FROM A SOURCE OF FRESH AIR EXTERNAL TO THE ENVIRONMENT BEING ENTERED. WITH THE AIRLINE RESPIRATOR, AIR IS SUPPLIED THROUGH A SMALL DIAMETER AIR LINE FROM A SOURCE OF COMPRESSED AIR. WITH BOTH TYPES OF RESPIRATORS, THE AIR IS PROVIDED TO THE WEARER BY MEANS OF A CONNECTING HOSE OR AIR LINE. (c) AIR PURIFYING RESPIRATORS IN WHICH THE CONTAMINATED AIR IS PASSED THROUGH A CLEANSING MECHANISM WHICH IN COMMERCIALLY AVAILABLE UNITS FOR USE IN ATMOSPHERES CONTAINING ORGANIC VAPORS CONSISTS OF AN ABSORBENT BED OF ACTIVATED CHARCOAL.

IT SHOULD BE EMPHASIZED THAT ALL RESPIRATORS HAVE VARIOUS LIMITATIONS INHERENT IN THEIR APPLICATION AND INTENDED USE. THE BASIC FUNCTION OF THE PERSONAL RESPIRATORY PROTECTIVE DEVICE IS TO PROVIDE SOME INTERIM PROTECTION TO THE WEARER IN CASES WHERE EMERGENCY SITUATIONS ARISE; OR FOR A PERIOD OF SHORT EXPOSURE WHEN ENGINEERING CONTROL OF THE CONTAMINANT IS NOT FEASIBLE. A PROGRAM OF USAGE OF PERSONAL RESPIRATORY PROTECTION CANNOT IN ANY SENSE BE CONSIDERED AN ALTERNATIVE TO

ADEQUATE ENGINEERING CONTROL OF CONTAMINANTS. ACCORDINGLY, IT IS INAPPROPRIATE TO CONSIDER IMPLEMENTATION OF A PROGRAM WHICH REQUIRES FULL-TIME USAGE OF PERSONAL RESPIRATORY PROTECTION AS PART OF THE OCCUPATIONAL HEALTH PROTECTION STRATEGY.

THE LIMITATIONS AND DISADVANTAGES ASSOCIATED WITH THE VARIOUS TYPES OF RESPIRATORY PROTECTIVE DEVICES VARY FROM ONE TYPE OF UNIT TO ANOTHER. THE LIMITATIONS INHERENT IN THE AIR PURIFYING RESPIRATORS ARE SO SIGNIFICANT THAT CONSIDERATION OF THEIR USAGE IN A PROGRAM WHICH REQUIRES FULL-TIME PROTECTION BY RESPIRATORS IS NOT APPROPRIATE. THE PRIMARY ADSORBENT (ACTIVATED CHARCOAL) WHICH IS TYPICALLY EMPLOYED IN THE COMMERCIALLY AVAILABLE RESPIRATORS FOR USE IN ATMOSPHERES CONTAINING ORGANIC VAPORS HAS ONLY LIMITED CAPACITY IN STOPPING PASSAGE OF VINYL CHLORIDE VAPORS. IN ADDITION, WITH USE OF THE AIR PURIFYING RESPIRATORS, THERE IS NO MECHANISM FOR THE WEARER TO KNOW THE PRESENT STATUS OF HIS RESPIRATOR, THAT IS, THE REMAINING USEFUL LIFE. VINYL CHLORIDE POSSESSES NO WARNING PROPERTIES, I.E., ODOR OR IRRITATION, ETC. THE LIFE EXPECTANCY OF THE AIR PURIFYING RESPIRATORS IS NOT ONLY LIMITED, BUT UNKNOWN AT ANY POINT

DURING ITS USAGE. IN ADDITION, SINCE THE AIR PURIFYING RESPIRATORS RELY ON THE RESPIRATORY SYSTEM OF THE WEARER TO DRAW AIR THROUGH THE CARTRIDGES CONTAINING THE AIR PURIFYING ADSORBENT, A NEGATIVE PRESSURE IS CREATED WITHIN THE FACE PIECE OF THE RESPIRATOR DURING INHALATION. THERE ARE INHERENT DIFFICULTIES IN PROVIDING AN EFFECTIVE SEAL FOR THE RESPIRATOR FACE PIECE AGAINST THE WEARER'S FACE BECAUSE OF VARIATION IN FACIAL FEATURES, THE WEARING OF GLASSES AND PRESENCE OF BEARDS, LONG HAIR OR MUSTACHES.

IT IS NECESSARY THEREFORE TO TAKE SPECIAL PAINS TO BE SURE THAT A SATISFACTORY FIT IS OBTAINED. IN THIS CONNECTION, IT IS ESSENTIAL THAT USERS OF SUCH MASKS BE ADEQUATELY TRAINED SO THAT THEY CAN BE SURE THAT THE MASK IS FUNCTIONING PROPERLY (THAT IS, WITHOUT SIGNIFICANT LEAKS) EACH TIME IT IS USED.

IN SUMMARY THEN, THE USE OF AIR PURIFYING RESPIRATORS IS CERTAINLY NOT APPROPRIATE FOR SUSTAINED, LONG-TIME PROTECTION AGAINST SIGNIFICANT CONCENTRATIONS OF VINYL CHLORIDE IN THE AIR. HOWEVER, IF PROPER PRECAUTIONS ARE TAKEN TO ASSURE THAT THE FACE PIECE FITS PROPERLY AND THAT THE CANISTER HAS AMPLE CAPACITY, I BELIEVE THAT

CANISTER-TYPE MASKS ARE SUITABLE FOR SHORT-TERM USE IN ATMOSPHERES WHERE THE VINYL CHLORIDE CONCENTRATION IS NOT TOO HIGH.

THOSE RESPIRATORY PROTECTIVE DEVICES WHICH HAVE INCORPORATED IN THEM PROVISIONS FOR SUPPLYING FRESH AIR TO THE WEARER DO PROVIDE AN ADEQUATE FACTOR OF RELIABILITY IN THAT IT IS NOT NECESSARY FOR THE RESPIRATOR TO "PURIFY" THE AIR BEING SUPPLIED. HOWEVER, THERE ARE GROSS LIMITATIONS ASSOCIATED WITH ANY OF THE "ATMOSPHERE-SUPPLYING RESPIRATORS".

THE SELF-CONTAINED BREATHING APPARATUS UNITS, SINCE THEY HAVE ASSOCIATED WITH THEM A SUPPLY OF AIR OR OXYGEN WHICH IS CARRIED BY THE WEARER, ARE AFFECTED IN THEIR USE OVER PROLONGED PERIODS OF TIME BY THE LIMITED LIFE OF THE AIR SUPPLY. IN ADDITION, THE UNITS ARE OF CONSIDERABLE WEIGHT AND SIZE, THE MOST SIGNIFICANT EFFECT OF WHICH IS A DRAMATIC IMPAIRMENT OF THE MOBILITY OF THE WEARER.

THE HOSE MASK OR AIRLINE-TYPE OF RESPIRATORS HAVE ASSOCIATED WITH THEM ADDITIONAL DISADVANTAGES INCLUDING THE SAFETY HAZARD POSED BY POTENTIAL TRIPPING OVER THE AIR SUPPLY LINE, THE POSSIBILITY OF KINKING AN AIRLINE,

THUS SHUTTING OFF THE SUPPLY OF AIR OR OXYGEN. FURTHERMORE, SINCE THE WEARER IS CONNECTED TO THE SOURCE OF AIR BY AN AIR LINE, HE MUST EXIT EACH AREA BY RETRACING HIS STEPS. THIS LATTER POINT NOT ONLY HAMPERS HIS MOBILITY, BUT POSES SIGNIFICANT LIMITATIONS ON HIS ABILITY TO REACT TO EMERGENCY SITUATIONS ENCOUNTERED IN ANY WORK AREA.

ALL OF THE AIR SUPPLY TYPE OF RESPIRATORS HAVE GENERAL LIMITATIONS WHICH MUST BE CONSIDERED IN CONTEMPLATING PROGRAMS REQUIRING THEIR USE. ALL RESPIRATORS DECREASE THE FIELD OF VISION OF THE WEARER TO SOME EXTENT. THOSE UNITS INCORPORATING THE FULL-FACE MASK HAVE A VERY SERIOUS RESTRICTING EFFECT ON THIS FIELD OF VISION. AS A RESULT, THE WEARER OF THE FULL-FACE PIECE MASK IS NOT AWARE FULLY OF ACTIVITIES IN HIS IMMEDIATE WORK AREA, THUS POSING A SERIOUS POTENTIAL SAFETY HAZARD. IN ADDITION, IT IS VIRTUALLY IMPOSSIBLE TO CONDUCT VERBAL COMMUNICATIONS WHILE WEARING ANY TYPE OF RESPIRATORY PROTECTIVE EQUIPMENT. ADDITIONALLY, SOME AIR SUPPLIED RESPIRATORS OPERATING IN A POSITIVE PRESSURE MODE AND INCORPORATING THE FULL HEAD COVERING MASK OR SHROUD HAVE ASSOCIATED WITH THEM EXCESSIVE NOISE LEVELS.

THIS NOT ONLY SERIOUSLY AFFECTS THE ABILITY OF THE WEARER TO HEAR VOICE COMMUNICATIONS OR OTHER AUDIBLE SIGNALS INCLUDING EMERGENCY ALARMS, BUT CAN PRESENT A SIGNIFICANT HEALTH HAZARD AND AT LEAST AN ANNOYANCE DUE TO THE INHERENT NOISE LEVEL WITHIN THE MASK.

IN CONCERNS DEALING MORE DIRECTLY WITH HEALTH RELATED POTENTIAL HAZARDS, IT IS RECOGNIZED THAT SOME WORKERS, BECAUSE OF KNOWN OR UNKNOWN IMPAIRMENT IN THEIR RESPIRATORY SYSTEMS, SIMPLY CANNOT AND SHOULD NOT BE REQUIRED TO WORK UNDER CONDITIONS WHICH REQUIRE THEM TO WEAR PERSONAL RESPIRATORY PROTECTIVE EQUIPMENT BECAUSE OF THE INCREASED BURDEN ON THEIR LUNGS. IN ADDITION, IT IS QUITE APPARENT THAT SUSTAINED PERIODS OF USE OF PERSONAL PROTECTIVE EQUIPMENT RESULT IN FATIGUE, ANNOYANCE AND MILD FRUSTRATION TO THE EXTENT THAT THE WEARER BECOMES MORE "ACCIDENT PRONE" THAN A WORKER NOT HAVING TO USE SUCH EQUIPMENT. SOME INDIVIDUALS, BECAUSE OF TENDENCIES TOWARDS CLAUSTROPHOBIA, SHOULD NOT BE REQUIRED TO WEAR EQUIPMENT THAT IS AS CONFINING AS PERSONAL RESPIRATORY PROTECTIVE DEVICES.

WITH ANY PROTECTIVE EQUIPMENT THAT UTILIZES PROVISIONS FOR SUPPLYING FRESH AIR OR OXYGEN TO THE WEARER, THERE IS AN OBVIOUS NEED FOR A PROGRAM TO MONITOR

THE QUALITY OF THE AIR OR OXYGEN WHICH IS BEING SUPPLIED. THIS IS PARTICULARLY CRITICAL WITH NETWORKS OF AIR SUPPLY LINES THROUGH A PRODUCTION FACILITY THROUGH WHICH FRESH AIR IS SUPPLIED FROM A CENTRAL COMPRESSOR. THE POSSIBILITY OF CONTAMINATION OF THE AIR SUPPLY, EITHER BY CONTAMINANTS GENERATED BY THE COMPRESSOR EQUIPMENT OR BY RECYCLING OF CONTAMINATED AIR STREAMS, MUST BE AVOIDED. THE HUMIDITY OF THE AIR SUPPLIED BY SUCH SYSTEMS TYPICALLY IS MAINTAINED AT VERY LOW LEVELS TO PREVENT PROBLEMS ASSOCIATED WITH CONDENSATION IN THE LINES. AGAIN THIS PRESENTS A SIGNIFICANT POTENTIAL HEALTH HAZARD TO THE WEARER IN THAT HE WOULD BE EXPOSED TO LOW HUMIDITY AIR FOR PROLONGED AND CONTINUOUS PERIODS OF TIME, THE CONSEQUENCES OF WHICH WOULD BE ADVERSE EFFECTS ON THE RESPIRATORY SYSTEM.

ALTHOUGH QUANTITATIVE EVIDENCE DOCUMENTING ADVERSE EFFECTS (INCREASED ACCIDENT FREQUENCY, IMPAIRED HEALTH, ETC.) IN INDUSTRIAL OPERATIONS CHARACTERIZED BY PROGRAMS REQUIRING WORKERS TO WEAR PERSONAL RESPIRATORY PROTECTIVE EQUIPMENT FOR SUSTAINED PERIODS OF TIME IS VIRTUALLY NON-EXISTENT, IF EVEN POSSIBLE TO OBTAIN, IT IS CLEARLY IN VIOLATION OF GOOD INDUSTRIAL HYGIENE PRINCIPLES AND PRACTICE TO IMPLEMENT PROGRAMS REQUIRING FULL-TIME USE OF PERSONAL RESPIRATORY PROTECTIVE EQUIPMENT.

IN SUMMARY, THEN, FOR THE REASONS DISCUSSED, IT IS MY OPINION THAT IT IS JUST NOT PRACTICABLE, AND INDEED IT IS IN MANY WAYS UNSAFE, TO OPERATE A CHEMICAL PRODUCTION FACILITY WHEN THE WORKING FORCE IS REQUIRED TO WEAR RESPIRATORS OF ANY TYPE ON A FULL-TIME BASIS. HOWEVER, I DO BELIEVE THAT IT IS NOT UNREASONABLE TO EXPECT THAT SUCH PLANTS COULD BE OPERATED IF THE WORKING FORCE WERE REQUIRED TO WEAR RESPIRATORY PROTECTION DURING ONLY A PART OF THE WORKING DAY. IN THIS LATTER CASE, I WOULD RECOMMEND THAT CANISTER-TYPE MASKS (WITH PROPER PRECAUTIONS) BE USED WHERE THE CONCENTRATION OF VINYL CHLORIDE PERMITS BECAUSE OF THE GREATER MOBILITY AND FREEDOM OF MOTION THAT IS PERMITTED TO THE WEARER. WHERE THE CONCENTRATION OF VINYL CHLORIDE IN THE ATMOSPHERE EXCEEDS THE SAFE WORKING RANGE OF CANISTER-TYPE RESPIRATORS, IT IS MY OPINION THAT ONLY AIR SUPPLIED RESPIRATORS OF SUITABLE DESIGN BE USED.

carbon for analysis can be achieved either by solvents or by heating. If solvents are used, carbon disulfide is the preferred eluting solvent. It, however, is extremely flammable and precautions must be taken to avoid exposure of fumes to open flames, sparks, and heat.

Alternately, any vinyl Chloride collected can be desorbed by heating the adsorbent tube to 430°C and flushing with 12 liters of dry nitrogen gas, collecting the gas in an appropriate bag. Both elution procedures appear to produce accurate, reproducible results.

If the sample collection tubes are not analyzed immediately, care must be taken to avoid additional contamination or loss of vinyl chloride. It is preferable to analyze the samples within several days of their collection.

Obviously, all sampling and analytical instruments should be calibrated and tested before use and the initial results compared to duplicate samples taken for analysis by the reference method.

Sampling Frequency:

The number and frequency of samples required to insure a safe and healthful work environment requires judgment. Continuous area monitoring can be used as a processing aid to allow for early detection of leaks and losses so that equipment can be maintained. It can notify the employee of a contaminated area so that proper protective equipment can

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be worn to prevent exposure.

With adequate continuous monitoring of the work area, less frequent personnel monitoring is needed to document employee exposure. if the continuous monitors indicate that the work environment is in compliance with established standards, an annual personnel monitoring program should suffice. If continuous area monitors demonstrate that potentially hazardous areas exist, a quarterly personnel monitoring program by job classification should be done.

Summary and Recommendations:

1. Reference analytical methods should be established in the permanent OSHA vinyl chloride standard.

2. Continuous area monitoring should be installed in those areas with potential employee exposure. Several different instruments and methods are acceptable, depending on each particular location and manufacturing situation. Whichever instrument or method is used, it should be checked no less than quarterly against the Reference Method using air samples as similar as practicable to those extant in the work environment.

3. Annual personnel monitoring should be done in those plants with continuous area monitors. Personnel monitoring should cover each job classification, with potential exposure under typical operating conditions. Quarterly personnel monitoring should be done, by job classifications

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and under typical operating conditions, in those plants without continuous area monitors.

4. Gas chromatography, or where it is available, gas chromatography-mass spectrometry should be established as the instrument in the Reference Method.

5. All results should be recorded as the time-weighted average (TWA) for the period of actual sampling time.

Thank you.

JUDGE MYATT: Thank you, Dr. Stehl.

(Statement of Dr. Stehl was marked as Exhibit 20-L.)

STATEMENT OF DR. ROBERT D. SOULE, VICE PRESIDENT, INDUSTRIAL HYGIENE SERVICES FOR GEORGE D. CLAYTON AND ASSOCIATES

DR. SOULE: Judge Myatt, my name is Robert D. Soule of 4221 Marywood Drive, Troy, Michigan. I am currently Vice President, Industrial Hygiene Services for George D. Clayton and Associates, an environmental health consulting organization located in Southfield, Michigan with a branch in Fallbrook, California.

I was present during the testimony and cross examination of Mr. Hyatt on Tuesday on behalf of the Department of Labor, and during the testimony of Mr. Tomashefski yesterday on behalf of the Society of the Plastics Industry. I consider my testimony to be in all essential respects consisten-

however, I do believe that it is not unreasonable to expect that such plants could be operated if the working force were required to wear respiratory protection during only a part of the working day.

In this latter case, I would recommend that canister type masks (with proper precautions) be used where the concentration of vinyl chloride permits because of the greater mobility and freedom of motion that is permitted to the wearer. Where the concentration of vinyl chloride in the atmosphere exceed the safe workinggage of canister type respirators, it is my opinion that only air supplied respirators of suitable design be used.

Thank you.

JUDGE MYATT: Thank you.

Mr. Reporter, Dr. Soule's written statement will be entered into the record as Exhibit 20-H.

(Dr. Soule's statement was marked as Exhibit No. 20-H.)

STATEMENT OF ROGER D. STRASSBURG, DIRECTOR OF ENVIRONMENTAL AFFAIRS, THE B. F. GOODRICH COMPANY

DR. STRASSBURG: Judge Myatt, my name is Roger V. Strassburg. I am Director of Environmental Affairs for the B. F. Goodrich Company.

I received my Doctorate in the field of organic chemistry from the University of Minnesota in 1950. I have

held positions with the B. F. Goodrich Company during the past 23 years in research, technical management, research and development administration and general administration.

I want to tell you about some of the major objections to portions of the proposed standard which would require that air-fed respirators and self-contained air supplies be worn by workers in an environment where the level of vinyl chloride is detectable.

Since a "no-detectable" level of vinyl chloride isn't feasible, the requirement I just mentioned would mean the full-time use of air-fed respirators, and self-contained air supplies by all employees for their full work terms throughout the vinyl monomer and polymer industry.

This is impractical and even hazardous for reasons I will explain in a moment.

However, employees may use air supplied protective devices while they are cleaning reactors or unloading vinyl monomer from tank cars into storage facilities.

In addition, these devices should be available for emergency use if there is a major emission of vinyl chloride in the work atmosphere.

The proposed standard would sanction only four types of respirators. These are:

(1) a positive pressure full facepiece self-contained breathing apparatus;

(2) a pressure-demand full facepiece self-contained breathing apparatus operating in the pressure demand mode;

(3) a combination Type "C" pressure-demand full facepiece respirator operating in the pressure demand mode and a pressure demand self-contained breathing apparatus operating in the pressure demand mode; or

(4) a combination Type "C" continuous flow respirator and a pressure demand self-contained breathing apparatus operating in the pressure demand mode.

These four types of respirators allow only self-contained air supplies. However, in checking with other industries, we have learned that hose supplied, air-fed respirators can be used in confined areas, such as in handling radioactive material, welding and spray painting. The hose is usually no longer than 25 feet and generally there is no traffic in the work area.

In our industry, workers who clean polymerization vessels, or polys, also fit this type of activity and the hose, as opposed to a cumbersome air tank, makes it easier to enter the vessel.

With an air tank, the operator would have to enter the vessel and have the tank passed down to him, reversing the procedure when coming out. The hose supplied system has its place, as in this application, but it is not generally applicable to entire plants.

Self-contained air supplies, or tanks, also have limitations on general use. They are heavy, weighing about 30 pounds. Some workers cannot wear them at all, and many workers commonly experience fatigue after wearing them a short while.

Furthermore, the 30 pound self-contained air supply lasts only 30-60 minutes. Frequent recharging with high pressure equipment, at least 12 to 16 times a day for each employee would be necessary.

To our knowledge, no plants are equipped to recharge hundreds of air tanks each day. Even if the equipment were available, the logistics of this exchange process, especially in the larger plants, are almost insurmountable.

Like air hose, there is a place for self-contained air supply as an effective means of providing respiratory protection for employees, for example, in unloading tank cars, where the use of self-contained air supply would be intermittent. Built-in air packs are also effective for some emergency escape situations.

The regular use of masks, whether full-face, or half-face, regardless of the air source, presents a different set of problems.

This is true despite the fact that masks of all types have undergone extensive research.

Yet, there still is no "ideal" mask.

We have learned from employers in other industries that the continuous use of masks by employees causes many problems. These include headaches, irritation behind the ears, ingrown hair, inflamed facial glands, and edema of the scalp.

Full-face masks are designed primarily to be used where both eye and respirator protection is needed. Eye irritation is not a problem in the vinyl industry.

In fact, the use of full-face masks with air-fed respirators results in drying of the eyes and fogging of the face plate or eyeglasses. This could be a safety hazard. Furthermore, full-face masks are difficult to fit properly over eyeglasses.

The larger skin contact of a full-face mask also increases the possibility of various skin irritations or aggravation of existing facial problems.

Half-face masks have slightly lower respiratory efficiency than full-face masks. Where the use of air-fed respiratory protection is required, this slight reduction in efficiency can largely be overcome through the use of air tanks or air-fed hose while eliminating most of the problems associated with full-face masks.

In a carefully monitored manufacturing plant, assuming a feasible level of exposure is established, employees would be alerted by an alarm system when this level is exceeded and appropriate respiratory equipment would be utilized.

This typical situation would involve an excursion above pre-determined levels. In these instances, following established safety procedures, employees would be alerted to the higher than normal level and required to wear half-face masks with canister protection. This procedure would provide readily available protection for all employees during the time it takes to find and correct the problem.

I now want to tell about some of the results of experimental work we have done at B. F. Goodrich on canisters.

Canisters, properly maintained, we have learned through experimental work, will last approximately 11 hours at levels up to 100 ppm when tested at 32 liters per minute, the normal breathing rate.

Mr. Hyatt on Tuesday commented on the deficient service life of cartridges. We have had similar experience on three and four inch cartridges, although our breakthrough times at 100 ppm were of the order of 30 to 40 minutes.

However, in canister masks, where he lacked experimental data, we would like to make this further contribution.

An experimental flow chamber to test various types of adsorbents was set up to measure the adsorbtion-desorbtion characteristics of vinyl chloride monomer at flow rates of 32 and 64 liters per minute as specified by NIOSH.

Calibrated flow meters were used to produce concentrations of vinyl chloride monomer from below one ppm to

MR. LASSITER: Thank you very much.

One further question with scope here that borders on my last question. That is, given your answer that there is perhaps a shortage of occupationally trained physicians throughout industry, and given the fact that we have attempted in the standard to slant the test--besides a general medical examination--towards liver pathology, would you have some suggestions of how general practitioners that are available to industry would become aware of the specific problems that they should be looking for in terms of angiosarcoma, liver, all the other medical problems that have been indicated with exposure to vinyl chloride?

DR. JOHNSON: I think if they were made aware of the fact that there was the possibility of liver cancer, most of them would know how to pursue a proper examination for liver cancer.

Regrettably, there is nothing specific about the angiosarcoma. It is simply another liver cancer, and the same procedures would be used as for any other type.

MR. LASSITER: Then, I take it, if by the scope you feel that the examination should not be exclusively orientated towards liver pathology, would you suggest that we delete the serum examination that we have prescribed here from the standard and simply say that the physician should consider the possibility of liver concer?

DR. JOHNSON: That would be an appropriate way, I think, to give him the maximum flexibility.

MR. LASSITER: Thank you.

The next questions I have are for Mr. Stehl.

On your testimony concerning area monitoring versus personnel monitoring, which type--personnel monitoring or area monitoring--do you feel gives the most accurate estimation of actual individual employee exposure to vinyl chloride of the two?

DR. STEHL: Do you wish the emphasis to be attached as far as accuracy?

MR. LASSITER: To the individual. The most accurate estimation of actual individual employee exposure to vinyl chloride.

DR. STEHL: I think personnel monitors are the most accurate.

MR. LASSITER: Do you consider, then, with your recommendation that personnel monitoring should be used simply as backup to area monitoring?

DR. STEHL: Yes.

MR. LASSITER: May I ask why you recommended that only annual personnel monitoring be accomplished as a backup to area monitoring?

DR. STEHL: It was my expectation that the area monitoring on a continuous sequential basis would provide the

kind of continuous indication necessary to ensure stable plant operation and record of the kind of concentrations of vinyl chloride existing in the atmosphere, and that the function of personnel monitoring would be to provide a continued update on particular work practices associated with different job classifications.

MR. LASSITER: Then you think annually is sufficient to adjudge this?

DR. STEHL: Yes, I think so.

MR. LASSITER: Do you consider that area monitoring or personnel monitoring will provide the most complete exposure record of employee exposure to vinyl chloride?

DR. STEHL: That's very difficult to judge. I'm not sure that with the amount of data that exists in one work situation on both types--I don't think I could make a judgment at this point.

MR. LASSITER: When you talked about reference methods in your recommendation, are these reference methods in terms of performance?

DR. STEHL: Yes.

MR. LASSITER: When we are talking about area monitoring, how would you determine which places to monitor that provide the most representative sampling points?

DR. STEHL: I think this requires an experimental program to determine what the point-to-point and time-to-time

Ex 20N

STATEMENT OF ROGER W. STRASSBURG, DIRECTOR OF ENVIRONMENTAL AFFAIRS, THE B.F.GOODRICH COMPANY

PREPARED FOR

PRESENTATION AT

DEPARTMENT OF LABOR HEARINGS ON VINYL CHLORIDE OCCUPATIONAL EXPOSURE STANDARD, JUNE 25, 1974

My name is Roger W. Strassburg. I am director of environmental affairs for The B.F.Goodrich Company. I received my doctorate in the field of organic chemistry from the University of Minnesota in 1950. I have held positions with The B.F.Goodrich Company during the past twenty-three years in research, technical management, research and development administration and general administration.

I want to tell you about some of the major objections to portions of the proposed standard which would require that air-fed respirators and self-contained air supplies be worn by workers in an environment where the level of vinyl chloride is detectable.

Since a "no-detectable" level of vinyl chloride isn't feasible, the requirement I just mentioned would mean the full-time use of air-fed respirators and self-contained air supplies by all employees for their full work turns throughout the vinyl monomer and polymer industry.

This is impractical and even hazardous for reasons I will explain in a moment.

However, employees may use air-supplied protective devices while they are cleaning reactors or unloading vinyl monomer from tank cars into storage facilities. In addition, these devices should be available for emergency use if there is a major emission of vinyl chloride in the work atmosphere.

The proposed standard would sanction only four types of respirators. These are:

(1) a positive pressure full facepiece self-contained breathing apparatus;

(2) a pressure-demand full facepiece self-contained breathing apparatus operating in the pressure-demand mode;

(3) a combination type "C" pressure-demand full facepiece respirator operating in the pressure-demand mode and a pressure-demand self-contained breathing apparatus operating in the pressure-demand mode; or

(4) a combination type "C" continuous flow respirator and a pressure-demand self-contained breathing apparatus operating in the pressure-demand mode.

These four types of respirators allow only self-contained air supplies. However, in checking with other industries, we have learned that hose-supplied, air-fed respirators can be used in confined areas, such as in handling radioactive material, welding and spray painting. The hose is usually no longer than 25 feet and generally there is no traffic in the work area.

In our industry, workers who clean polymerized vessels, or polys, also fit this type of activity and the hose, as opposed to a cumbersome air tank, makes it easier to enter the vessel.

With an air tank, the operator would have to enter the vessel and have the tank passed down to him, reversing the procedure when coming out. The hose-supplied system has its place, as in this application, but it is not generally applicable to entire plants.

Self-contained air supplies, or tanks, also have limitations in general use. They are heavy, weighing about 30 pounds. Some workers cannot wear them at all and many workers commonly experience fatigue after wearing them a short while.

Furthermore, the 30 pound self-contained air supply lasts only 30-45 minutes. Frequent recharging with high-pressure equipment, at least 12-16 times a day for each employee, would be necessary. To our knowledge, no plants are equipped to recharge hundreds of air tanks each day. Even if the equipment were available, the logistics of this exchange process, especially in the larger plants, are almost insurmountable.

Like air hose, there is a place for self-contained air supply as an effective means of providing respiratory protection for employees,

for example in unloading tank cars, where the use of self-contained air supply would be intermittent. Smaller air packs are also effective for some emergency escape situations.

The regular use of masks, whether full-face or half-face, regardless of the air source, presents a different set of problems.

This is true despite the fact masks of all types have undergone extensive research.

Yet, there still is no "ideal" mask.

We have learned from employers in other industries that the continuous use of masks by employees causes many problems. These include headaches, irritation behind the ears, ingrown hair, inflamed facial glands and edema of the scalp.

Full-face masks are designed primarily to be used where both eye and respirator protection is needed. Eye irritation is not a problem in the vinyl industry.

In fact, the use of full-face masks with air-fed respirators results in drying of the eyes and fogging of the face plate or eye glasses. This could be a safety hazard. Furthermore, full-face masks are difficult to fit properly over eye glasses.

The larger skin contact of a full-face mask also increases the possibility of various skin irritations or aggravation of existing facial problems.

Half-face masks have slightly lower respirator efficiency than full-face masks. Where the use of air-fed respiratory protection is required, this slight reduction in efficiency can largely be overcome through the use of air tanks or air-fed hose while eliminating most of the problems associated with full-face masks.

In a carefully monitored manufacturing plant, assuming a feasible level of exposure is established, employees would be alerted by an alarm system when this level is exceeded and appropriate respiratory equipment would be utilized.

This typical situation would involve an excursion above predetermined levels. In these instances, following established safety procedures, employees would be alerted to the higher-than-normal level and required to wear half-face masks with canister protection. This procedure would provide readily available protection for all employees during the time it takes to find and correct the problem.

With the permission of my colleagues at SPI, I now want to tell about results of some experimental work we have done at B.F.Goodrich on canisters.

Canisters, properly maintained, we have learned through experimental work, will last approximately 11 hours at levels up to 100 ppm when tested at 32 liters per minute, the normal breathing rate. An experimental flow chamber to test various types of adsorbents was set up to measure the adsorption-desorption characteristics of vinyl chloride monomer at flow rates of 32 and 64 liters per minute as specified by NIOSH.

Calibrated flow meters were used to produce concentrations of vinyl chloride monomer from below 1 ppm to 10,000 ppm within the NIOSH specified flow limits. Detection of vinyl chloride monomer in the air stream was accomplished with a calibrated, commercially available flame ionization detector. Independent calibration was accomplished by the use of commercially prepared samples and gas chromatography.

In a typical experiment, a stream of vinyl chloride monomer in air at a particular flow rate was passed through a canister in such a way that the entire stream passed through. The sampling probe from the flame ionization detector was placed at the exit of the canister. In this continuous monitoring mode, initial vinyl chloride monomer breakthrough was accurately determined from the recorder output of the detector.

CANISTER DATA
64 liters/minute

Concentration	Breakthrough Time		
25 ppm	T_o= 8.3 hrs.	T_1= 8.7 hrs.	T_5= 9.4 hrs.
100 ppm	T_o= 5.6 hrs.	T_1= 5.7 hrs.	T_5= 6.0 hrs.
1000 ppm	T_o= 1.6 hrs.	T_1= 1.7 hrs.	T_5= 1.8 hrs.

The canister's greater capacity offsets the current lack of an indicator to signal exhaustion of the canister. Prospects are good that a reliable indicator for canisters will be developed in the near future. Canister suppliers and at least one university are working diligently to provide a color indicator that will tell employees when it is time to change their individual canisters. Until such time as indicators are developed, there would be no objection to any requirement that any canister which has been used at all be changed at the end of each work shift.

In summary, we believe respiratory protection with canisters is necessary only when exposure exceeds the established level, but remains well below emergency conditions.

However, there are certain types of operations, as we indicated, that require either air-fed hose, such as in cleaning polys, or air tanks, as in the case of tank car unloading and emergency situations.

In establishing permanent standards, SPI urges that OSHA allow management the necessary flexibility to select and utilize the most appropriate respiratory equipment for the protection of our employees.

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Mr. Strassburg was asked to testify on canister gas masks and I think broadening the area of inquiry to areas that he may not be as expert in as Goodrich's own witnesses will just unduly prolong the record.

JUDGE MYATT: I think that objection is well taken, and I suggest that you save that for the Goodrich people when they are here.

MR. SAMUELS: I must accept it, but I would point out that the Government started that line of questioning, and no objection was made by the good counsel at that time.

JUDGE MYATT: Your recollection then exceeds mine. I do not recall the Government doing that. But, nonetheless, save it for Goodrich.

MR. CONNOLLY: Mr. Strassburg, would you describe for the record what the situation would be like in a plant where the no detectable limit was implemented if people were working in air line respirators and the cords were, say, in excess of 50 feet or a hundred feet or in excess of 200 feet, and the safety hazards that might be caused by cords as high as, as was indicated by the Government, as high as 300 feet?

MR. STRASSBURG: Well, you'd have the normal problems that occur when you drag along a hose or a wire behind you--tripping, tangling--kinking, these kinds of things.

MR. CONNOLLY: Do you think it would be feasible

to run a plant with every employee on a 300-foot cord?

MR. STRASSBURG: Well, I doubt that it would.

MR. CONOLLY: Thank you.

JUDGE MYATT: Are there any other questions?

All right, we are going to take a five-minute recess

[A brief recess was taken.]

JUDGE MYATT: Gentlemen, we have arrived at the point where we have the last panel from SPI.

Before they start, I think it only fair to share with you the results of the discussion that I have had with the OSHA people during the recess.

As I indicated yesterday, we will probably go through to a half day on Saturday. At the rate we are going, I do not see how we can physically get through this list that is before me of all of those who are to appear and make presentations.

[Continued on page following.]

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make fabricated products.

MS. HRICKO: Nearly all of the levels that you presented of monitoring at the B. F. Goodrich plants, in Diamond Shamrock processing plants, were below one ppm. Would these plants have to close down if the OSHA proposed standard went into effect?

MR. WEAVER: As Mr. Smith answered, if the PVC resin producers could not make resin, then we would not have resin to operate those processing plants.

MS HRICKO: And if they could, in exactly the same form as you are obtaining now.

MR. WEAVER: I didn't get that question.

MS HRICKO: If they could produce resin in exactly the same form as they are producing it now, would these plants have to close down in October when they would be covered by the OSHA permanent standard for vinyl chloride?

MR. WEAVER: No, if they could obtain resin, they would certainly continue to operate.

MS. HRICKO: Thank you.

JUDGE HYATT: Are there any other questions?

MR. CONNOLLY: Could I ask all four a question, of where they would plan to get the resin if the units were closed down in October?

MR. BECKER: I think it's a hypothetical question. I don't think you could get the resin.

MR. CONNOLLY. Pavlon?

MR. BUCHER: I don't believe you could get the resin.

MR. WEAVER: Mr Smith needs much more resin. I will let him answer.

MR CONNOLLY: I would like each one of you to answer the question, because I don't want the record to be contaminated by the prior question.

Could you get it inside the United States?

MR. WEAVER: No, you would not be able to obtain the PVC resin inside the United States who operate processor plants. And based on my knowledge of the tightness of supply of petrochemicals and the resulting supply of ethylene that you need to produce, to make vinyl chloride monomer around the world, there is a very definite shortage of vinyl chloride monomer, and PVC resin worldwide.

I am sure, as the Japanese have been doing for the past [illegible], they would not share it with PVC processors.

MR CONNOLLY: The gentleman from Diamond Shamrock has already indicated he can't. Mr. Smith?

MR. SMITH: I have no earthly idea where we would get it.

MR. CONNOLLY: Mr. Beebe?

MR. BEEBE: I wouldn't know where to get it.

MR. CONNOLLY: So if you could not get the resin,

your five plants would also close down, I take it?

MR. BEEBE: Right.

MR. CONNOLLY: Thank you very much.

JUDGE MYATT: Any other questions?

Mr. Fleming?

MR. FLEMING: Mr. Weaver, you characterize the plants that you studied, or that you served, really, as a number of very small processors of limited technical capacity and the like.

MR. WEAVER: Yes, sir.

MR. FLEMING: If the other provisions of the standard, let alone the resin supply -- but if the other provisions of the proposed standard were imposed on people of this type, could they live up to those other parts of the standard, in your view, and stay in business?

MR. WEAVER: You're talking about medical surveillance and monitoring?

MR. FLEMING: Masks and so on and reporting, all of the miscellaneous burdensome detail that goes in the standard designed for entirely different purposes than under discussion at the moment.

MR. WEAVER: I would certainly hate to see the small businessman loaded with that additional detail that he is really not equipped to do. The small businessman certainly will be on the witness stand later this week, and

STATEMENTS OF JOSEPH FATH, VICE PRESIDENT;
PAUL LOBO, DIRECTOR, TECHNICAL GROUP,
ORGANICS AND POLYMERS DIVISION; AND
PHILIP SCARITO, WORKS MANAGER, BURLINGTON,
NEW JERSEY--TENNECO CHEMICALS, INC.

MR. FATH: Thank you, your honor. My name is Joseph Fath. I am a vice president of Tenneco Chemicals, and the general manager of its Organics and Polymers Division. I was graduated from Cornell University with a bachelor's degree in chemistry in 1944. For the past 28 years, I have held various research, business development and senior management positions in the chemical sector, including direct research, development and technical experience of 14 years in the polyvinyl chloride field and an overall experience of 18 years in that industry.

Tenneco opposes OSHA's proposed permanent standard for vinyl chloride and generally supports the position outlined by the witnesses for the Society of Plastics Industry. The standard of no detectable amount of ambient vinyl chloride is not feasible. Adoption of the proposed OSHA standard would leave Tenneco with the following options:

(1) We would have to place all our operating and support personnel at our PVC manufacturing sites in respirators all of the time; or

(2) Tenneco would have to cease the manufacture

of PVC which we are currently producing at a rate of 240 million pounds per year with 500 million pounds projected for 1975 and beyond.

The consequences of the latter option have already been reviewed by the SPI. I want to reiterate on behalf of Tenneco that discontinuing the manufacture of PVC would have tremendously disruptive effects on the defense, wire and cable, construction, automotive and the phonograph record industries.

It is neither safe nor feasible to place vinyl chloride workers in respirators for the full duration of a work shift. However, given the serious nature of available scientific and medical evidence regarding potential human health effects of vinyl chloride inhalation, management, union leadership, the Federal government, and the medical community must, in concert, agree that the only conceivable course of action for industry is the maximum feasible reduction of human exposure to airborne concentrations of vinyl chloride monomer. Though a no detectable standard is not feasible, it is, nevertheless, incumbent upon the industry to take every technologically and economically feasible step to reduce levels of ambient vinyl chloride.

I am accompanied by Dr. Paul Lobo, Director of our Technical Group for Tenneco's Organics and Polymers Division, and by Mr. Philip Scarito, Works Manager of our

Burlington, New Jersey, facility. They will supplement my general presentation with a more detailed analysis of the proposed standard's lack of feasibility from the engineering and plant operations viewpoint, while pointing out the steps that Tenneco has taken or will take to reduce worker exposure to vinyl chloride. I shall outline to you the elements of a position which Tenneco considers to be feasible and which incorporates the best work practices within the shortest possible period of time. It is appropriate at this time, however, to profile briefly Tenneco's facilities and work force.

Tenneco is involved in all three stages of production associated with the various polyvinyl chloride manufacturing operations. Our Pasadena, Texas, facility produces vinyl chloride monomer. Our Flemington and Burlington, New Jersey, plants manufacture 36 different resins through a number of complex polymerization processes. The various resins manufactured require different operating procedures and involve different types of technology. The potential vinyl chloride exposure problems, therefore, also differ widely from one process to another within the same site.

Further, at Burlinton we process resins with other chemicals and additives to form semi-finished vinyl compounds for subsequent fabrication. Our facilities at Nixon and Carlstadt, New Jersey, and at Newton, Massachusetts, process

vinyl chloride resins into a variety of fabricated products both rigid and flexible. At Tenneco, 15 employees are currently involved in monomer production, 343 in the manufacture of polyvinyl chloride resins, and 456 in the manufacture of fabricated products. Tenneco's production capacity for polyvinyl chloride is about to be significantly augmented by the opening of a new facility at our Pasadena, Texas, chemical complex, using a new large reactor technology. This facility will employ an additional 60 individuals.

Tenneco has researched the work history and cause of death of the 20 persons, out of a total of 1,029 personnel employed over the course of our 17 years of operation, who have died while still employed at our monomer and polymer facilities. None have died from angiosarcoma of the liver. Tenneco participated in the epidemiological survey of the industry conducted by Tabershaw-Cooper Associates whereby cause of death was researched for certain former Tenneco employees. Again, no former Tenneco employee, found by the Tabershaw-Cooper researchers, had died from cancer of the liver.

The vinyl chloride industry has grown during the last 30 years from production at the multi-hundred-million-pound level to today's five billion pounds. During this same period, employee exposure to vinyl chloride has been drastically reduced because technical advances have enabled

automation of some manual operations, ventilation has improved, leaks have been subjected to greater controls, and work practices have improved materially. In this regard, it is interesting to note that the 13 U.S. PVC industry employees discovered to date to have contracted angiosarcoma of the liver were employed at four of the five oldest plants in the industry. There is up to now no human experience data indicating that angiosarcoma will result from the substantially lower levels of exposure that have existed in the industry during more recent years.

We cannot, however, ignore these tragic worker deaths. We must, therefore, take every reasonable and feasible step, first, to reduce individual employee exposure and, second, to reduce the number of employees potentially exposed within the estimated 700,000 employee work force of the vinyl industry. This must be accomplished without causing severe consequences to numerous consumer and defense activities that would result from a serious disruption in the production of polyvinyl chloride, the nation's most versatile thermoplastic polymer.

The proposed permanent standard assumes that members of the industry will be able to meet its requirements through a combination of engineering improvements, work practice changes, and the use of respirators. This assumption is not justified. Compliance with the proposed standard

cannot be accomplished as a practical matter. Because of the current configuration of industry plants, the fact that batch processing is employed and the current state of technology, the practical effect of the proposed standard will be to require employees to wear respirators essentially all of their time spent in the regulated work areas described in the standard. The result is not viable for plant operations and is inconsistent with the proposed standard. Dr. Lobo will describe in greater detail the obstacles to eliminating vinyl chloride exposure through engineering changes, and Mr. Scarito will describe the likely consequences for employee safety, morale and production efficiency, of the necessity of employees wearing respirators during the entire day. I shall now address myself to some of the specifics of what we at Tenneco feel we can accomplish in reducing worker exposure to vinyl chloride in our polymerization and processing facilities.

While, as I have already noted, we support the industry proposal outlined by the Society of Plastics Industry for the three types of operations, namely VCM production, PVC resin production and fabrication facilities for vinyl goods, I would like specifically to state Tenneco's position on its most significant manufacturing activities--that of PVC resin production and fabrication facilities for vinyl goods.

The elements of this position are as follows:

(1) We propose a constant, sequential monitoring of all areas within the PVC polymerization plant sites. We consider this method a vastly superior and a more conscientious technique of checking existing levels than personnel monitoring systems. We believe that the proposed system will do more to prevent and correct prolonged dosages of vinyl chloride than any other mechanical correction possible in our existing plants. Further, it will enable us to diagnose with greater reliability the existence of potential problem areas. The proposed system will be connected to gas chromatography apparatus and will yield a permanent record of constant exposures throughout the plant site. We have these systems on order and expect them to be delivered within a reasonable time.

(2) It is essential and self-evident that the permanent standard recognizes the need for a time period during which engineering and operational changes can be made in line with the more detailed proposals you will hear from Messrs. Lobo and Scarito. I understand that the standard must by law go into effect on October 5, 1974. Exposure levels to be complied with as of that date will apply to PVC plants before engineering solutions, design specifications and purchase and delivery of vital equipment can be accomplished, because completion of these actions

will take two to three years. It must be noted that since the entire industry will be required to make comparable changes, there will be delays beyond normal lead time. Thus, our proposal will include exposure levels which are based upon what we consider to be the practical elements of compliance feasibility.

(3) Another vital element of our position is that we propose the drastic reduction of residual monomer content in the polyvinyl chloride resin to be delivered to our customers to 100 ppm or 0.01 percent maximum by October 5, 1977. This residual monomer constitutes the only source of VCM which is released from PVC resin because PVC does not depolymerize. In other words, the polymer itself, once formed, does not generate vinyl chloride monomer. By reducing this level and processing the PVC resin with such reduced levels in the fabricating plants, we have determined from preliminary experimental results, that we would expect to remove essentially the entire work force involved in the vinyl fabrication industry from any vinyl chloride exposure. When it is recognized that only about one percent of the 700,000 workers in the vinyl industry are actually employed in the manufacture of vinyl chloride monomer and polyvinyl chloride, the remainder being employed in the processing sector, this plan will eliminate within a short time any possible health hazard from 99 percent of the vinyl industry

work force. To us, this represents the most rapid containment of the current problem with the proposed exposure levels for the remaining industry segments representing the limits of technological feasibility.

(4) Let me now state our position with regard to employee exposure levels in our PVC polymerization plants. It will be feasible for Tenneco to comply with the levels of exposure presented by the SPI witnesses. Those levels call for, as of October 5, 1974, a ceilingof 40 ppm before donning of respiratory equipment is required, with a 25 parts per million time-weighted average. As of October 5, 1975, the ceiling should be lowered to 25 parts per million before respiratory equipment is required. As of October 5, 1976, we propose adding to the ceiling of 25 parts per million maximum, a time-weighted average of 10 parts per million based on an eight-hour day. Once we have had some experience with constant sequential monitoring, we will have a more realistic basis for knowing whether we can accelerate the attainment of the levels in the proposed standard presented by the SPI witnesses. Every effort will be made to reach these levels within the shortest practicable time.

To reach these levels of exposure in the time frame I have described, Tenneco will probably have to spend in excess of $10,000,000 and incur additional annual operating

costs amounting to millions of dollars. Until medical data and experiment can establish a safe or widely acceptable risk threshold for vinyl chloride exposure, we feel that we must do everything feasible to reduce worker exposure.

In sum, although the standard proposed by OSHA is not feasible, Tenneco intends to do everything reasonable and feasible not only to reduce exposure of workers in monomer and polymer facilities, but also to assure protection of the much larger work force that processes PVC resins.

We hope that reason will prevail and that all interested parties, including the Federal Government, labor, the medical community and the management of the polyvinyl chloride industry can communicate and cooperate toward the important goal of minimizing vinyl chloride exposure to the maximum extent feasible, without causing the severe economic consequences that could attend application of unrealistic and impossible standards.

I would like to turn the presentation over to Dr. Lobo.

DR. LOBO: Judge Myatt, my name is Paul Lobo and I am Director of the Technical Group for the Organics and Polymers Division of Tenneco Chemicals. In this capacity, I am in charge of engineering as well as the research and development activities of this division. I received a B.S. and M.S. degree in chemical engineering from the

Massachusetts Institute of Technology and a doctorate in chemical engineering from the University of Michigan. I have had 19 years experience in the chemical industry in the field of research and development, engineering and technical management. Eight of these years were spent developing commercial processes from the laboratory through the pilot plant to commercial plant design and start-up.

Based on the presently available technology, it is not feasible for existing polyvinyl chloride facilities to meet the proposed OSHA standard through engineering changes. Further, the proposed standard cannot be met through any combination of engineering changes and altered work practice methods, without the use of respirators 100 percent of the time. As I understand it, the proposed standard does not contemplate use of respirators 100 percent of the time. If the standard were to result in the full-time use of respirators, as Mr. Fath has pointed out and as Mr. Scarito will detail, we are convinced that this would not be a practical mode of operation. I will defer to Mr. Scarito on the respirator and work practices questions and focus my remarks on the engineering implications of the proposed standard.

Tenneco's polymer facilities range in age between five and 17 years. Our Flemington, New Jersey, plant was originally constructed in 1957, and extensively rebuilt in

1969. It produces approximately 85 million pounds per year. Our Burlington, New Jersey, facility consists of four distinct plants having a total capacity of 150 million pounds per year. Two of these make PVC resins, homopolymers and vinyl acetate copolymers by the suspension process, and were built in 1961 and 1964, respectively. Plants making resin by the dispersion method were added in 1965 and 1969. A new large suspension resin plant is scheduled to begin operations at our Pasadena, Texas, facility in the fall of 1974. It will produce approximately 250 million pounds per year.

All our plants currently in operation were constructed based upon the best knowledge of vinyl chloride processing available at the point in time when they were built. None were built with the knowledge that exposure of vinyl chloride monomer may constitute a serious health risk to workers beyond the known anesthetic and flammable properties of this gas. Although up-to-date engineering practices were used in their design and construction, there exists no practical, quick corrective means to bring these facilities into conformance with a standard of no detectable level of VCM in the plant areas. In this conclusion, I include even our most modern facility that is expected to begin operation in Texas this coming fall.

In the design of PVC polymerization facilities, a

batch or discontinuous chemical process is employed by Tenneco and the rest of the industry. Such a process requires opening of processing vessels after one or more batches have been polymerized; the removal of water, unreacted monomer and inerts from the polymer after the reaction through a series of stripping, venting and drying steps, and finally the bagging or bulk loading of a solid material at the end of the process. All of the Tenneco plants as well as most others in the industry have, for safety reasons, been designed so that these various operations are separated from one another by considerable distances. Therefore, the problem of emissions is not confined to a relatively small and manageable area, but is one that exists throughout an entire multi-acre plant site.

On the other hand, vinyl chloride monomer production at our Pasadena, Texas, plant and all other industry facilities is a continuous chemical process carried out within a substantially closed system. It is easier to reduce monomer emissions and hence ambient levels when one is dealing with a continuous, closed system. It is for this reason that we support the proposal presented by the SPI witnesses for a more stringent standard for monomer plants than for polymer plants.

There are four principal facets of the polymer manufacturing process that can lead to worker exposure to

vinyl chloride monomer. First, the monomer usually arrives at the polymer facility by tank car or by truck and at this unloading stage, some exposure is unavoidable since transfer hoses must be hooked and unhooked. Workers currently wear air-supplied respirators for these unloading tasks. However, because of the coupling and uncoupling steps involved, emissions in this area can contribute to the general levels ofVCM on the site. We have changed our unloading techniques to reduce these emissions considerably, even though these changes represent a lowering of operating efficiency. We are not able, however, to eliminate entirely the escape of some VCM in this area.

Second, in all of our existing plants the walls of reactor vessels must be cleaned by workers since deposits of polyvinyl chloride form on them during the polymerization process. These deposits prevent the heat, which is released during the reaction, to be removed through the wall of the vessel, thus interfering with the process and creating a potential safety hazard. Further, if these deposits are permitted to remain, such safety devices as relief valves may become clogged posing a further threat to workers' safety. Additionally, if a clean reactor is not used, product quality can be degraded to a point where it becomes useless to the plastic processor.

We have found means to increase the number of

batches that can be processed before it is required that a worker enter the reactor to clean it. Frequency of reactor entry can be further reduced through employment of certain cleaning technology which Tenneco is currently developing, and our future plans to minimize worker exposure presuppose installation of improved cleaning processes or procedures. However, even with these processes, it is very likely that periodic vessel entry will be required to assure that the mechanical internals are in working condition and emergency relief valves have not become blocked by polymer and thus rendered inoperable.

A third source of worker exposure is leakage from mechanical equipment, that is, compressors, pumps and valves. In the design of our facilities, sound engineering practices were used to select such equipment; however, this was in accordance with known technology, exposure limits then considered safe and the nature of the processes utilized. Contrary to the claims that some have made, this leakage cannot be eliminated through installation ofa few readily available substitute valves and pumps.

There do exist some low-volume pumps that have been field-proven which can help "tighten up" certain stages of our operations. These pumps will be installed as part of our program to minimize worker exposure. For higher volume applications, there are available so-called

canned pumps which might reduce vinyl chloride leakage but they have not been tested in PVC plant applications such as slurry service. We cannot be confident of their feasibility in our installations at this time.

The fourth and most significant amount of vinyl chloride escape results from the drying stage of the resin production process. The drying stage is a necessary facet of suspension and dispersion processes used in the Tenneco plants. Some of our dryers are gigantic rotating kilns, 50 feet long and 10 feet in diameter, which use immense volumes of air, 30,000 cubic feet per minute or more, to remove water from the resins. During this processing step, quantities of residual monomer not removed in the earlier stripping stage are removed from the polymer and some of the monomer escapes into the plant site area.

One approach which has been suggested to remove VCM from the ambient air is adsorption by activated carbon. This is considered wholly impractical where large volumes of air and small concentrations of VCM are involved. In our new Pasadena plant, we have included carbon adsorption to recover VCM from two small process streams, neither of which contains air, but even this limited application has yet to be tested on a commercial plant scale.

Because of the factors I have just described, it is not feasible by engineering changes utilizing presently

available technology, to modify our existing plants to meet the proposed standard, nor can a combination of work practices and engineering changes achieve that result. However, steps can be taken to reduce employee exposure to vinyl chloride. With these steps, Tenneco hopes by October 1976 to reduce vinyl chloride monomer exposure levels to 10 parts per million (time-weighted average) with a ceiling excursion of 25 parts per million.

Our program includes installation of:

A very extensive sequential area monitoring system to insure conformance and to indicate excursions;

New, low leakage pumps;

Equipment to minimize reactor entry for cleaning;

Ventilation equipment totally beyond the scope of our current operation; and,

An extensive manifolding system so as to permit utilization of respiratory equipment where needed.

It will also include the isolation of certain key areas from worker exposure and extensive addition of processing equipment to attain stripping and monomer recovery efficiencies far beyond our present capability.

It should be noted that these extensive modifications dictate the prompt placement of orders for such equipment since current delivery and installation schedules range upwards of two years. While we have already ordered some

of this equipment, it must also be realized that design specifications cannot be made until a permanent standard has, in fact, been defined. Such design specifications do not exist for the proposed "no detectable" level.

In addition, Tenneco has under way significant research and development efforts already mentioned by Mr. Fath, the goal of which is to eliminate the highest possible percentage of monomer from the resin prior to the drying stage. To date, our laboratory studies have shown that monomer levels in certain of our resins can be reduced substantially below the 0.01 percent level, which is 100 ppm. Our research and development program is currently geared toward translating these results into the commercial plant. These improved techniques will require the further addition of equipment which is subject to the same lengthy delivery schedules.

This development effort, if successful, should result not only in a drastic lowering of the residual monomer content in our resins, but also should aid in greatly reducing the amount of monomer released in the drying stage. This will aid in reducing monomer levels in the PVC plant site area. In addition and most important, the downstream vinyl processors will benefit from these lower contained monomer levels in the resin, resulting in the substantial elimination of exposure to the hundreds of thousands of

workers involved in that industry.

Preliminary studies show that the capital expenditures needed to meet our goal of 10 parts per million time-weighted average monomer exposure in 1976 will probably exceed $10 million and that additional labor and operational costs will total in the millions of dollars per year. Even after these extensive and costly changes, we estimate that certain job classifications will be required to wear respirators some part of the time. We believe that this percentage of respirator use represents the tolerable maximum for Tenneco's workers.

Tenneco will continue to seek engineering solutions to the problem of worker exposure to vinyl chloride monomer. My testimony has concerned itself with the problems we face and the plans we currently have to deal with them based on research and development goals and current technology.

MR. FATH: Now Mr. Scarito will continue our presentation with the manufacturing aspects of the proposed standard.

MR. SCARITO: My name is Philip Scarito and I am the works manager of Tenneco's Burlington, New Jersey, polymer and compounding facility. I was graduated from the Massachusetts Institute of Technology in 1937 with a bachelor's degree in chemistry. For the past 18 years, I have served in plant manager assignments at three separate Tenneco

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polyvinyl chloride facilities. For the past eight years, my responsibilities at the Burlington site have encompassed all aspects of the manufacturing operations including work practices and safety.

As both Mr. Fath and Dr. Lobo have already pointed out, compliance with the proposed permanent work standard would require for the foreseeable future, use of air-supplied respirators by polyvinyl chloride workers 100 percent of the time that they spend in regulated work areas, which would encompass all of the physical plant. Based upon my experience in polyvinyl chloride facilities, I feel strongly this is neither an appropriate, safe nor feasible solution to the problem of worker exposure to vinyl chloride monomer since it would entail substantial health and safety risks in and of itself. In this regard, Tenneco has already experienced one lost time accident when a worker suffered a fall from a ladder as a result of his using a lengthy air hose attached to a breathing apparatus.

A typical vinyl chloride polymerization facility is a multi-story operation, has many catwalks or narrow passageways, stairwells, moving machinery and, in general, areas where dragging an extended length of hose become difficult and hazardous. I believe the safety hazards inherent in a man's being required to trail behind him a 25-foot or longer length of air hose are quite obvious and do

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require further elaboration. This hazard is increased significantly in several jobs where the travel distance of an operator for certain specific operations could require lengths of air hose well in excess of 100 feet. Added to the built-in hazards of long lengths of hose is the fact that certain operations involve multi-level work assignments. Backpack type air supply is neither a practical nor an acceptable substitute for hose-supplied air because of the weight and bulk of the units. Also, I could not from my own experience recommend regular use of so-called cannister masks under a no-detectable level standard because, first, of the difficulty of ensuring their continued effectiveness with continuing exposure; and, second, because their failure cannot be detected readily by the worker.

The full face masks required by the proposed permanent standard limit a worker's field of vision on both a vertical and a horizontal plane. They reduce very significantly and, in the case of some respirators, totally interfere with a worker's hearing. Many of the manufacturing procedures in a polyvinyl chloride facility require that an employee be able to hear and to respond to audible alarms. This is vital both from a process control point of view as well as a pure and simple safety consideration. Air-supplied respirators definitely reduce a worker's ability to hear some of these important alarms at the very least;

and, in many cases, will definitely prevent him from hearing and responding to others. Likewise, the wearing of such a respirator will make difficult communicating by voice, and this creates an additional operational inefficiency as well as possibly generating a very real potential hazard.

It is my feeling that the use of respirators for prolonged periods will definitely contribute to worker fatigue, which will again increase the possibility of unnecessary injuries. I am sure that the tolerance of continuous wearing of respirators will vary considerably from worker to worker; but in a polyvinyl chloride operation, we cannot afford to introduce factors which diminish a man's reaction capabilities. There will undoubtedly be some employees who are susceptible to claustrophobia, and it is my opinion that these employees will simply not be able to wear the required respirators. Additionally, I suspect that longtime use of air respirators may well lead to lung and throat damage.

A further problem, which is very real, is that I feel it will become difficult, if not impossible, to staff our plants when prospective employees know that they will be required to wear respirators full time. Realistically, I feel that we may lose many of our key present employees for the same reason.

Though nose and mouth respirators as compared to

full face respirators reduce some of the problems of the limited field of vision, hearing, and claustrophobia, they still present the problems of accidents from tripping, constriction of vertical vision, and the possible injury to throat and lung tissues from extended use.

The drafters of the proposed standard appear to have recognized the problems I have outlined. The standard states: "Respirators shall be used only in cases of emergency...and...respirators may not be used in lieu of feasible engineering controls or work practice methods." Since, as has already been discussed, engineering controls and work practice methods cannot yield a no-detectable level environment, the consequence of the standard is to require use 100 percent of the time of air-supplied respirators, an outcome that OSHA and industry apparently agree is not acceptable.

Tenneco has undertaken the following steps to reduce ambient vinyl chloride in plant areas through use of work practices and tolerable maximum use of respirators:

(1) Taking siding from the building--some of the buildings;

(2) Added ventilation;

(3) Installation of manifold air-supplied system to completely cover all of the reactor building areas at all levels as well as other necessary plant areas;

(4) Issuance to each worker of a full-face air-supplied respirator for reasonable use when necessary;

(5) Improved stripping of residual monomer from the wet slurry and thereby reducing vinyl chloride in the air during subsequent processing;

(6) As an interim step, prior to the installation of sequential monitoring, we have introduced the use of organic vapor analyzer monitoring to identify minute leaks not otherwise detectable; and

(7) Improved work practices relating to the cleaning of reactors.

Thank you.

JUDGE MYATT: All right. Mr. Klein?

MR. KLEIN: When I ask you a question, if any of you people feel competent to reply to it, you just do it, please.

Do you have with you today your measurements in monitoring that have been taken at your various plants?

MR. FATH: No, we do not have them with us, Mr. Klein, but they are available.

MR. KLEIN: Can you tell us, at each of your plants, representative figures with respect to worker exposure, if you remember them?

MR. FATH: Based on the personnel monitoring data that we now have, our figures fall into various categories,

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if I may speak of orders of magnitude. The Flemington site--we currently have two polymerization sites in our operation at Flemington and Burlington, New Jersey--the Flemington site, the majority of our readings are in the--all the way down to non-detectable in some areas to perhaps the 10 to 12 ppm area, with a minority of the readings in the perhaps 15 to 50 ppm area, and with a very low percentage above that in areas now identified as those requiring respiratory equipment.

MR. KLEIN: Would it be correct to assume that the areas you indicated as the source points, the problem source points, are the areas that would go from 15 to 50 ppm?

MR. FATH: No, I think rather those that would be above the 50 ppm level. These have been reasonably identified as those requiring respiratory equipment now in normal operation.

MR. KLEIN: Have you been able to identify the source points with respect to the 15 to 50 ppm area?

MR. FATH: These are random readings in the various operator areas, and we have identified some of those problem areas. But remembering that those readings are always after-the-fact readings, we do not know the extent of the duration of these, let's call them excursions above a normal pattern.

MR. KLEIN: Could you identify for us now what the exposure points are that you have identified at the 15 to 50

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MR. FATH: For the most part they are in the reactor area, as I recall the data.

MR. KLEIN: Would you be able to make that information available to us, sir?

MR. FATH: Yes, I would.

MR. klein: Now that we have covered the Flemington plant, could we go through the rest of the plants, please?

MR. FATH: Yes. At our Burlington plant--and I might ask Mr. Scarito to comment in greater detail--taking the same patterns of orders of magnitude into consideration, our Burlington plant is an entirely different plant in that it is what we consider a mixed plant, wherein we practice some four different polymerization technologies within the same site, in buildings that are in rather close proximity to one another.

And so we have a much larger incidence of exposures in the readings of, let's say, 15 to 50 part per million area than we would at Flemington.

And these are scattered over a much wider job classification and area categories.

MR. klein: Could we go on to the rest of your plants briefly?

MR. FATH: Well, those are our two existing polymerization plants now; as I indicated in my testimony, we are constructing a PVC plant in Texas, but that is not yet

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in operation. We do have there a monomer producing facility, a small one, and in that plant our levels are considerably lower, mostly in the area between 0 and 10 parts per million, due to the fact that it is a continuous process and it is totally outdoors.

MR. KLEIN: Have you been able to project at the plant under construction approximate exposure levels to employees there?

MR. FATH: We feel that that plant will be able to meet the ultimate level that we have proposed as a limit of feasibility sooner than the remainder of our plants, for which we have projected a two-year level to achieve that point.

MR. KLEIN: What technical controls or work practices will exist at the new plant that would account for the difference in terms of your lowering the exposure levels?

MR. FATH: The fundamental difference in that plant, aside from the fact that it will be a brand-new plant, with new equipment not subject to prior wear, is the fact that it will have fewer but larger reactors and that, due to its southern location, will have a larger percentage of its total equipment located out of doors.

As to the work practices, perhaps Dr. Lobo can add to it.

DR. LOBO: There will be two other elements which

we feel will assist us in reducing the exposure to the levels of VCM in the plant site area. One of these will be that we will receive the monomer by pipeline. The second is that this technology which we have licensed does provide for less problems in the reactor cleaning area.

MR. KLEIN: How have you dealt with the problems in the cleaning area at the new plant?

DR. LOBO: This is licensed technology, Mr. Kline, and I am not free to discuss the details of it, but it does make it simpler to clean the reactor between batches and it minimizes the problems in the cleaning process.

MR. KLEIN: Can you tell us whether it is an automated process?

DR. LOBO: The present state of technology requires that the reactor be open between each batch, and at this stage it is necessary for a man to enter the reactor between each batch. That is the present state of the technology.

But the problems are less than in the conventional polymerization system or the other technology practiced in the country.

MR. KLEIN: The statement you just made applies to the new plant?

DR. LOBO: To the new plant, correct.

MR. KLEIN: I would like to direct your attention to page 5 of your testimony, the only full paragraph. Have

understanding of the routine activities required of employees in these industries; and is directed, in major part, to the consideration of the feasibility of conducting plant operations while the employees wear respirators on a full time basis.

The type of personal respiratory protective device which is selected for use must be a direct function of the nature and extent of the hazard, the conditions of the work place and requirements for the jobs in which the workers are engaged, and the characteristics and limitations of the respirators available for use.

There are basically three types of respiracors which are available for use in atmosphers containing vapors of organic substancess in general, and vinyl chloride in particular. These include (A) self-contained breathing apparatus which incorporates a supply of air, oxygen or oxygen-generating material which is actually carried by the wearer of the respirator; (B) the hose mask and airline respirators which incorporate a mechanism for providing the wearer with a source of fresh air.

The basic difference between the hose mask and airline respirators is that with the hose mask respirator, air is supplied with or without means of a blower from a source of fresh air external to the environment being entered. With the airline respirator, air is supplied through a small diameter air line from a source of compressed air.

With both types of respirators, the air is provided to the wearer by means of a connecting hose or air line.

(C) Air purifying respirators in which the contaminated air is passed through a cleansing mechanism which in commercially available units for use in atmospheres containing organic vapors consists of an absorbent bed of activated charcoal.

It should be emphasized that all respirators have various limitations inherent in their application and intended use. The basic function of the personal respiratory protective device is to provide some interim protection to the wearer in cases where emergency situations arise; or for a period of short exposure when engineering control of the contaminant is not feasible.

A program of usage of personal respiratory protection cannot in any sense be considered an alternative to adequate engineering control of contaminants. Accordingly, it is inappropriate to consider implementation of a program which requires full time usage of personal respiratory protection as part of the occupational health protection strategy.

The limitations and disadvantages associated with the various types of respiratory protective devices vary from one type of unit to another. The limitations inherent in the air purifying respirators are so significant that considerations of their usage in a program which requires full time protection by respirators is not appropriate.

The primary adsorbent (activated charcoal) which is typically employed in the commercially available respirators for use in atmosphers containing organic vapors has only limited capacity in stoppingpassage of vinyl chloride vapors.

In addition, with use of the air purifying respirators, there is no mechanism for the wearer to know the present status of his respirator, that is, the remaining useful life. Vinyl chloride possesses no warning properties, for example, odor or irritation, et cetera.

The life expectancy of the air purifying respirators is not only limited, but unknown at any point during its usage. In addition, since the air purifying respirators rely on the respiratory system of the wearer to draw air through the cartridges containing the air purifying adsorbent, a negative pressure is created within the face piece of the respirator during inhalation.

There are inherent difficulties in providing an effective seal for the respirator face piece against the wearer's face because of variation in facial features, the wearing of glasses and presence of beards, long hair or mustaches.

It is necessary therefore to take special pains to be sure that a satisfactory fit is obtained. In this connection it is essential that users of such masks be adequately trained so that they can be sure that the mask is

functioning properly (that is, without significant leaks) each time it is used.

In summary, then, the use of air purifying respirators is certainly not appropriate for sustained, longtime protection against significant concentrations of vinyl chloride in the air.

However, if proper precautions are taken to assure that the face piece fits properly and that the canister has ample capacity, I believe thatcanister type masks are suitable for short-term use in atmospheres where the vinyl chloride concentration is not too high.

Those respiratory protective devices which have incorporated in them provisions for supplying fresh air to the wearer do provide an adequate factor of reliability in that it is not necessary for the respirator to "purify" the air being supplied.

However, there are gross limitations associated with any of the "atmosphere supplying respirators."

The self-contained breathing apparatus units, since they have associated with them a supply of air or oxygen which is carried by the wearer, are affected in their use over prolonged period of time by the limited life of the air supply. In addition, the units are of considerable weight and size, the most significant effect of which is a dramatic impairment of the mobility of the wearer.

The hose mask or airline type of respirators have associated with them additional disadvantages including the safety hazard posed by potential tripping over the air supply line, the possibility of kinking an airline, thus shutting off the supply of air or oxygen.

Furthermore, since the wearer is connected to the source of air by an airline, he must exit each area by retracing his steps. This latter point not only hampers his mobility, but poses significant limitations on his ability to react to emergency situations encountered in any work area.

All of the air supply type of respirators hage general limitations which must be considered in contemplating programs requiring their use. All respirators decrease the field of vision of the wearer to some extent.

Those units incorporating the full-face mask have a very serious restricting effect on this field of vision. As a result, rhe wearer of the full-face piece mask is not aware fully of activities in his immediate work area, thus posing a serious potential safety hazard.

In addition, it is virtually impossible to conduct verbal communications while wearing any type of respiratory protective equipment. Additionally, some air supplied respirators operating in a positive pressure mode and incorporating the full head covering mask or shroud have asscciated with them excessive nose levels.

This not only seriously affects the ability of the wearer to hear voice communications, or other audible signals, including emergency alarms, but can present a significant health hazard, and at least an annoyance due to the inherent noise level within the mask.

In concerns dealing more directly with health related potential hazards, it is recognized that some workers, because of known or unknown impairment in their respiratory systems, simply cannot and should not be required to work under conditions which require them to wear personal respiratory protective equipment because of the increased burden on their lungs.

In addition, it is quite apparent that sustained periods of use of personal protective equipment result in fatigue, annoyance and mild frustration to the extent that the wearer becomes more "accident prone" than a worker not having to use such equipment.

Some individuals, because of tendencies towards claustrophobia, should not be required to wear equipment that is as confining as personal respiratory protective devices.

With any protective equipment that utilizes provisions for supplying fresh air or oxygen to the wearer, there is an obvious need for a program to monitor the quality of the air or oxygen which is being supplied. This is particularly critical with networks of air supply lines through a production

facility through which fresh air is supplied from a central compressor. The possibility of contamination of the air supply, either by contaminants generated by the compressor equipment or by recycling of contaminated air streams, must be avoided.

The humidity of the air supplied by such systems typically is maintained at very low levels to prevent problems associated with condensation in the lines. Again this presents a significant potential health hazard to the wearer in that he would be exposed to low humidity air for prolonged and continuous periods of time, the consequences of which would be adverse effects on the respiratory system.

Although quantitative evidence documenting adverse effects (increased accident frequency, impaired health, et cetera) in industrial operations characterized by programs requiring workers to wear personal respiratory protective equipment for sustained periods of time is virtually non-existent, if even possible to obtain, it is clearly in violation of good industrial hygiene principles and practice to implement programs requiring full-time use of personal respiratory protective equipment.

In summary, then, for the reasons discussed, it is my opinion that it is just not practicable, and indeed it is in many ways unsafe, to operate a chemical production facility when the working force is required to wear respirators of any type on a full-time basis.

you followed employees who had retired and were no longer employed by Tenneco?

MR. FATH: We have to the extent possible. I don't believe we would have a complete record of that, since there has been a great bit of movement.

MR. KLEIN: On page 6 you talk about automation of some manual operations. Could you tell us which operations you have automated, the details about those operations?

DR. LOBO: Well, as I mentioned in my testimony, we have reduced the exposure of employees by reducing the number of times that we have to clean the reactors--and this has been done by the installation of a high-pressure cleaning system in two of our plants, high-pressure water system.

This is probably the greatest area where we have made progress, from the standpoint of automation.

MR. KLINE: How often do employees now have to go into the reactor with the use of this method?

DR. LOBO: We practice a number of different technologies;in our dispersion plant, there is one problem; in the suspension, homopolymer, another problem; and copolymer and so forth. So it varies, but somewhere between once every five batches to perhaps once every twenty or twenty-five, depending upon the process.

MR. KLEIN: And could you give us a range as to how long it takes to clean a reactor?

DR. LOBO: About 30 minutes.

MR. KLEIN: Are there any other means of automation that you have instituted to reduce employee exposure?

DR. LOBO: We have, or will have, in our new facility a highly automated system, which will minimize the number of employees required to operate the plant, and minimize the number of employees that will be necessary in the polymerization reactor area, which in all our plants is the area of the highest level of VCM in the air.

MR. KLEIN: Is that information licensed as well?

DR. LOBO: Yes, it is.

MR. FATH: Mr. Klein, I might add another aspect of the automation which was alluded to previously. For a number of years we have had detection devices throughout our entire plant, which addressed themselves to gross excursions and lower explosive limits, which set off ventilation and deluge systems. I believe these have existed throughout many plants in the industry.

But they, of course, addressing themselves to gross excursions of monomer, are devices that have existed for a time much less long than the time the industry has been in operation.

What I am saying is, that it is unlikely that those devices had been installed in plants operating in the 1940's and many years ago.

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MR. KLEIN: Now, directing your attention to the improved ventilation systems, are there ventilation systems in the new plant that do not exist in your older plants?

DR. LOBO: No, there is nothing different in that aspect. What we have done in recent years is to increase the number of air changes per hour in our buildings. And our new plant will be designed on the same criteria. Also, as Mr. Fath mentioned, the new plant will be in the south and consequently it is generally open-air construction. This is a problem in the plants in the north, because they are all constructed inside buildings.

MR. KLEIN: Is there some major problem involved in ventilation control, using ventilation as a control?

DR. LOBO: In terms of moving enough air to meet some lower level of VCM ---

MR. KLEIN: Yes, in terms of removing the monomer.

DR. LOBO: I think in some cases we are approaching infinity in terms of the amount of air we would have to move to have an undetectable level. I think you can roughly calculate, maybe it is more academic--but one pound of VCM, if diluted with air uniformly would cover an area of 30 acres 15 feet high--and would equal one ppm.

MR. KLEIN: What technology in recent years have you used to control leaks better than you had previously?

DR. LOBO: We have upgraded our equipment, but we

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haven't been able to really solve the problem. We have most recently used our ovameter to determine the flanges, pump-packing, compressors and so forth, which are leaking--and giving those more maintenance. We are looking at adding pumps which will not leak or leak at lower levels, evaluating different types of valves which we feel might leak less.

But this is a development program.

MR. KLEIN: Now, I understand that you have dramatically reduced the levels of exposurevery recently, is my understanding correct?

DR. LOBO: I don't think that was said.

MR. KLEIN: No, I have just heard that, I just want to know if that is an accurate understanding on my part.

DR. LOBO: We have made good progress, but I think we are talking about coming down from perhaps 200 ppm in some areas now where we are 25 and 30, which has allowed us to operate in those areas without the use of the respirators. We have been pleased with our performance, but it is a long slow job.

MR. KLEIN: Other than the controls, practices, etc., that you have indicated today, are there any other means used to reduce the level of exposure of employees?

MR. FATH: Well, of course, we have used respirators a good percent of the time and have put certain operations

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on a standard respirator use procedure.

MR. KLEIN: How many hours a day do these employees wear the respirators?

MR. SCARITO: It varies, of course, with the jobs. It would range anywhere perhaps from five minutes for some employees to as high as perhaps an hour to an hour and 15 minutes at a time for other employees.

Is that what you meant?

MR. KLEIN: Yes. Now, at times when they are not wearing the respirators, are these employees in the ambient air that contains the vinyl chloride?

MR. SCARITO: What level of vinyl chloride?

MR. KLEIN: Any level.

MR. SCARITO: Well, yes, we have, as we have indicated before, there are measurable levels of vinyl chloride throughout the entire plant. And the employees are there.

MR. KLEIN: What level do you use as your cut off?

MR. SCARITO: Well, currently 50 is the cut off point at which we require mandatory use of respirators.

MR. KLEIN: Are there levels in your plant where the levels are below detectable level, as we define it in the proposal?

MR. SCARITO: Below no detectable?

MR. KLEIN: As defined in the proposal.

MR. SCARITO: I don't know of any area in the plant

that is below, that is zero VCM.

MR. KLEIN: How about one part per million?

MR. SCARITO: There are a few areas that we can measure at one to two parts per million, very few.

MR. KLEIN: Which areas are those?

MR. SCARITO: In general, they are the office most of the time, some of the outside areas, occasionally some of the warehousing areas, storage areas. These are the areas essentially where we find this low a level.

MR. KLEIN: Let's talk for a moment, if you will, about work practices that you have instituted which have improved--or decreased the level of exposure.

MR. FATH: Again, it would seem to me that the use of respirators and supplying additional ventilation, and a rather extensive measuring system throughout the plant by not only personnel monitoring, but organic vapor analysis, has helped us most to identify problem areas and to make actual corrections.

The big problem with personnel monitoring, when a high level occurs or a series of high levels occur within a low-level pattern, is the fact that these results come to us after the fact that these have occurred, and going back on those areas with organic vapor analysis equipment sometimes tends to identify the problem instantaneously.

And this is, of course, why the continuous

monitoring system is such an integral part of the proposal in that, from a time point of view, from a dosage point of view, it will do more to ring an alarm when a problem exists, permitting correction, than we feel any other part of the corrections that we can make.

MR. KLEIN: At what level have your monitoring devices been set to alarm?

MR. FATH: We do not have continuous monitoring installed in our plants at this point.

MR. KLEIN: Have you contemplated a level to have the alarm sound?

MR. FATH: Yes, we have. This would be the 40 part per million.

MR. KLEIN: Excuse me, I was referring to the monitors which detect the lower explosive limit. Have they ever gone off?

DR. LOBO: Yes, they have gone off a number of times, a good number of times being due to short-circuiting in the wiring. But they are set at 25 percent of the lower explosive limit. And to give an audible alarm. And then, at 50 percent, to turn on a deluge system which showers the area with water.

MR. KLEIN: Has it gone off because of vinyl chloride ---?

MR. SCARITO: Yes, we have had several occasions.

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In each and every case--there have perhaps been four or five over the last couple of years, since we have had the installation complete--in every case it has been due to a specific accidental discharge of monomer. By accidental, I mean not a routine gradual buildup of monomer in the area, but rather a specific blown gasket or something of this nature.

MR. KLEIN: I would like to now direct your attention to monitoring, for a moment. Is there a hardship in monitoring the employees, a hardship for you people, the employer, in monitoring the employee rather than in monitoring the system?

MR. FATH: It is not a hardship, it is an additional operation which increases in complexity as you increase the number of samples. And we feel that the continuous monitoring system will do that for us automatically and will maintain much better records and will maintain a more complete, let's say, exposure under a time curve than the discontinuous personnel monitoring will do.

Joe R. follows

MR. KLEIN: Does the monomer disperse the air equally?

MR. FATH: I think it has been testified before, and we tend to agree with this, that it tends to disperse rather sluggishly and concentrates more around the area of primary leak than disperse very quickly into a vast mass of air.

Of course, the extent of ventilation and air movement then helps to diffuse it through a larger body of air.

MR. KLEIN: Is there some reason why continuous monitoring would be more accurate measure as to what an employee's exposure to vinyl chloride is than would a monitor that is on the employee?

MR. FATH: Yes, we believe so. If you just, for the sake of numbers, assume a plant that has approximately 200 employees and one ten-minute sample per week would generate two hundred samples, and ten samples would generate, let us say, two thousand samples, this is not a hardship, it is just a lot of analytical work. And those ten samples, by way of example, would cover 100 minutes of that employee's presence of approximately 24 to 25 hundred minutes per week on the site.

The area, if monitored properly, will tell us what is going on in every one of the 2500 minutes, as an example of 42-hour week, of that employee's presence on that site and his movement through the various areas on the site.

MR. KLEIN: Now, on page 10 of the -- of Mr. Fath's testimony, you indicate these actions would take two or three years. The sixth line.

I am not sure I understand which actions you are talking about, to get to what level?

MR. FATH: The actions required regarding engineering solutions, design specifications, and purchase and delivery of the equipment in order to permit us to get to the tenth part per million time weighted average.

MR. KLEIN: On what basis do you say that it would take two to three years?

MR. FATH: Well, I believe we have delivery schedules of some of the vital pieces of equipment on hand, given to us by vendors, plus the normal installation times that are common to the industry.

I think our construction experience in Texas and in New Jersey indicates that these are normal kinds of constructing or constructing units, or modification of the plants.

MR.KLEIN: Do they indicate to you why there would be a to to three-year delay?

MR. LOBO: This is mainly due to a backlog of orders. We are in one of the biggest construction booms in the history of the country.

Some things are almost impossible to get. Three years

for some complex pieces of equipment is not unusual.

MR. FATH: I think I would like to modify the term "delay" here. I think these are normal in chemical construction. It is normal construction times. Delays would take us much beyond that period.

MR. KLEIN: Now, again directing your attention to page 10 of the testimony, you indicate that 100 parts per million unreacted monomer in the PVC by October of '77.

Could you tell us how you arrived at that date and the number, please?

MR. FATH: The basic number is an indication from current experimental work that we are doing. We fe[illegible]ther confident that over a number of our resins would [illegible] reduce residual monomer content below that point, therefore setting a hundred as, let us call it, a specification type of content.

MR. KLEIN: Could you make those experiments, experimental data available to us?

MR. FATH: We can make the results available to you. The methods how we got to them we consider property of Tenneco.

MR. KLEIN: And now about the date, October of '77?

MR. FATH: Well, this coincides with the prior comment on delivery and construction schedules. If we need to make integral modifications in our plant, then we need to

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order additional equipment to achieve this on a routine basis across our entire, essentially our entire capacity, and therefore the date really relates to, again, engineering changes, to arrive at these levels.

MR. KLEIN: Now, on page 11, also the bottom of page 10, you indicate that the monomer does not travel once it is combined.

Have you done any testing of this question to see whether the monomer would come out of perhaps the reactive polymer, or some way be released?

MR. FATH: I believe what we said that once the monomer is chemically converted into polyvinyl chloride, that process is not reversible. The monomer physically retained in the polyvinyl chloride is of course subject to potential release.

MR. KLEIN: Let us talk about the levels that you recommend with respect to the PVC levels.

Where did you get those numbers from and those dates?

MR. FATH: The levels in the waiting zones in the PVC polymerization plants?

MR. KLEIN: Yes, sir.

MR. FATH: In a sense, those levels work backwards from the level of maximum feasibility that we have determined.

In other words, we are saying that we conceptualize

today in our plants, with our technology, if all our engineering concepts materialize, a ten parts per million maximum time weighted average level within two years.

The other levels of proposed are, in a sense, then interim levels between the present and -- and a period two years from now. They are interim for several reasons.

Some of the modifications necessary can be made prior to the expiration of the two-year period and will have a minor improvement effect.

The other significant element is that because of the weight we place on the continuous monitoring system, and there I know that we are in good agreement in that concept with other witnesses that have testified previously, we consider the continuous monitoring system necessary to tell us where we really are today.

Because while we can generate perhaps thousands of ten-minute samples per week, the generation of those samples has a minor influence on time weighted average considerations.

Only a continuous understanding of the levels that we actually have will permit us to finalize our corrections to be made to go down to the ten parts per million level.

MR. KLEIN: Let me ask you this: Is the basis upon which you state here today or recommend here today those levels, essentially the same basis that SPI had, that is, it seemed to be the consensus of those present at

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the meeting that was discussed in their testimony, that that would be the level.

MR. FATH: Yes, it is.

I believe there is a common set of problems and therefore there is a consensus on the solutions to be applied to those problems.

MR. KLEIN: Would it be fair to say that you reached that same result as SPI, just based upon technical projection, sort of a judgment call, as it were?

MR. FATH: As a Tenneco judgment?

MR. KLEIN: Yes.

MR. FATH: As a Tenneco projection, yes, I think that is fair to say, and I think as part of the SPI group we have certainly made our views known, I am sure that our input was a part of the consensus consideration.

MR. KLEIN: What did you use as the point from which you projected?

MR. FATH: Well, as I stated before, the final point, and that is the ultimate, the lowest level we felt was practical to obtain --

MR. KLEIN: Excuse me. I would sort of define that as the point to which you projected. The point from which you projected. In other words, what facts and data did you project from in order to arrive at the conclusions that you apparently had arrived at?

MR. FATH: Well, the October 1974 date is reasonably close to the present, and as it relates to engineering improvements, that which we have not done to date, we will likely not then be able to do by October.

So we are using a general assessment of the current state.

I think it has been said before that the current state as of, let's say, June 1974, is a considerable improvement over conditions in January when we became aware of the problem.

MR. KLEIN: Now, I assume that there were PVC manufacturers who have levels that were considerably higher than yours, is that a fair assumption?

MR. FATH: On a personnel monitoring basis, yes, we have heard expressions from other -- from others that they had higher levels.

MR. KLEIN: Did this recommendation take into account the fact that these people have higher levels?

MR. FATH: No, it did not.

MR. KLEIN: Did it contemplate that some firms might not be able to get down to the level recommended?

MR. FATH: Yes, it did, certainly.

And I imagine that there might be testimony to that effect later on.

MR. KLEIN: I don't want to take the time of the

hearing now, but I would make a request to you: if you would, could you indicate to us the various job classifications and, as closely as you can, indicate what type, what the level of exposure is as to these job classifications and whether it is an intermittent type exposure or a general exposure?

I really don't want to take the time of the hearing now, but I think that explanation would be very useful to us.

MR. FATH: I presume that these are the compliance records that we now have at our plants?

Let us say, cross-referenced by operator classifications?

MR. KLEIN: Yes, I think so.

If you could do that, we would appreciate it.

MR. FATH: Yes, we will make that available.

MR. KLEIN: Thank you.

Which job classifications are presently using respirators at your PVC plants?

MR. SCARITO: There, the reactor operators for certain short-term operations, are using respirators. People who unload our monomer from the rail cars to our tanks wear respirators. Our cleaners, our vessel cleaners wear respirators. Our maintenance people on certain specific jobs where they may come in contact with residual vinyl chloride, wear respirators.

I guess that covers it pretty well.

MR. KLEIN: In reducing the levels of exposure, from leakage of mechanical equipment, have other than what you have indicated in testimony, , is there any other type of equipment that you put in or contemplate putting in, that you would expect would reduce the level of leakage?

MR. LOBO: Not really. I think there are various types of valves, various types of pumps, various types of compressors.

Obviously we are evaluating what is available, trying to determine whether it would be an improvement over what we are using.

MR. KLEIN: Have you found any to be an improvement?

MR. LOBO: Well, the so-called can pumps could be an improvement. Some valves would be an improvement over what we are using.

MR. KLEIN: Now, on page 8 of your testimony, Dr. Lobo, you indicate that activated carbon is wholly impractical where there are large volumes of air and concentrations of VCM are involved.

Could you indicate why that is, sir?

MR. LOBO: The application that we are considering here is of the possible use of activated carbon to remove the VCM from the dryer out of it which has been mentioned not only in our testimony previously at the hearings. It

is one of the major sources of contamination of the atmosphere.

Here we are looking at tremendously large carbon beds and very small concentration of VCM in the air, plus with air there is great concern about polymerization of the VCM on the carbon.

As I pointed out, even though there have been some claims that this was a panacea for the ills of the industry, we only have limited amount of data.

I must say that we haven't seen anything negative in the limited applications that we are looking at; that is where there is no air present.

But I don't see it as a practical solution to recovering VCM that might be present in only 100 to 200 parts per million, which is a general level in some of the dryer outlets.

MR. KLEIN: Would you be concerned that it wouldn't trap 100 percent of the monomer? Would that be a primary concern?

MR. LOBO: Just concerned that we are talking about very large piece of equipment, large pressure drops and [illegible] the problems of polymerization of VCM on the carbon itself.

MR. KLEIN: Have you done any experimentation in this area?

MR. LOBO: We have done some calculations to get some idea of the magnitude of the amount of carbon that might

be required.

MR. KLEIN: In situations where there is not a large volume of air with small concentration, where there is not a large volume of air but still there are small concentrations, would your view be different?

MR. LOBO: We feel that it is possible that this would do the job, and it is on this conclusion that we have installed this unit at Pasadena. I can report to you in five or six months whether our judgment was correct or not.

MR. KLEIN: I assume your judgment with respect to carbons to trap the monomer would apply equally to using carbon as a filter in the respirator; is that correct?

MR. LOBO: Yes, its action would be the same.

MR. KLEIN: Have you improved the efficiency of the recovery of the unreactive monomer in your plants?

MR. LOBO: Yes, we have.

MR. KLEIN: Is that process licensed?

MR. LOBO: We are improving this every day. We are not satisfied with our present achievements. We will need to add additional equipment to get what we feel is possible to get.

MR. KLEIN: What percentage of unreactive monomer do you have now?

MR. LOBO: It will vary between our plants, but generally the loss is between the three and four percent range.

MR. KLEIN: Is that a recent change or has that been the number more than six months?

MR. LOBO: This, I don't recall the exact numbers, but I say in some plants it has been an improvement of perhaps two or three percent over the last six months.

MR. KLEIN: Is the process by which you reduced the unreactive monomer a licensed process,, or can you tell us how you did it?

MR. LOBO: It is just applying good engineering principles. I think the knowledge is available to the industry. It just takes time to implement it.

MR. KLEIN: Do you know how, when you make a design specification, how you would project as to what the level of exposure would be after it was implemented?

MR. LOBO: This is a -- merely a judgment, since we have never operated at the lower levels, we really don't know whether we can get there or not until we are there. A very subjective thing.

MR. KLEIN: Returning just for a moment back to the unreacted monomer, have you found that in reducing the unreacted monomer that the resins that have resulted have been less useful further on down the line, or have they kept essentially the same qualities?

MR. LOBO: It depends how we do it. We have hurt the qualities of the resin by some of our experiments.

Other times we have been more successful.

MR. FATH: I think the distinction might be made here between the lowering of residual monomer contact in the resin and a lowering of losses across the plant.

In one case we are talking about lowering in terms of parts per million. In the other case we are lowering the lack of accountability, if you wish, of the loss in terms of percent numbers.

So the problems are not necessarily the same.

MR. KLEIN: On page 12 of your testimony, again you have indicated that certain employees in certain job classifications are required to wear respirators part of the time, and that you believe that that percentage of time represents the tolerable maximum.

No. 1, was the answer given before now represent rewhat nr you were talking about there, tolerable maximum?

MR. LOBO: Yes.

MR. KLEIN: On what basis do you conclude that one hour is the tolerable maximum?

MR. LOBO: This particular judgment is based on the comments made by Mr. Scarito as to the problems involved in wearing respirators and these are real in our plants. Whether it is the one hour or not.

MR. FATH: Again, Mr. Klein, I think we ought to distinguish between Mr. Scarito's comment that related to

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the present. One hour, one hour and a quarter. The present condition. We are not currently at the ten parts per million maximum referred to in Dr. Lobo's testimony.

In other words, we would expect the incidence of respirators to go up materially when we go down to the ten parts per million maximum.

MR. [illegible]. Do you have any recommendations as to maximum amount of time throughout an eight-hour day that the employee should be allowed to wear a respirator? Should be required to wear one?

MR. FATH[illegible]. We have no specific numerical recommendations.

MR. [illegible]. Mr. Scarito, have you performed any tests with respect to employees' hearing ability while wearing the full-face respirator?

MR. SCARITO: I don't know whether you would formalize it by calling it a test or not, but I have worn them myself. Many of our staff people have worn them to determine how readily they were able to see and operate and manipulate and so forth, and it's obviously quite restrictive. I can't put a number on it, but there's no question about it.

MR. [illegible]: So then your statement about respirators are based on your observations, then?

MR. SCARITO: Personal observations, mine and others.

MR. KLEIN: On page 5 of your testimony, you talk about taking siding from the building. Made to wear respirators.

Could you tell us how that works?

MR. SCARITO: Well, what we have tried to do is approach an outdoor plant, where practical, and improve ventilation by taking off sections of the siding.

MR. KLEIN: Thank you, Mr. Scarito, I have no further questions.

MR. KUCHENBECKER: One question I would like to direct to the panel.

From the standpoint of the number of workers exposed to vinyl chloride at your various plants, could you give me a rough idea of the number, the rate of employee turnover at the various production stages?

MR. FATH: Our particular turnover history?

MR. KUCHENBECKER: Yes, perhaps in the last two or three years.

MR. FATH: Well, of course, we have those data and we don't have them with us, but --

MR. KUCHENBECKER: Could you make those available?

MR. FATH: It is likely that perhaps a third of our workforce is in the zero to five year category. Perhaps somewhere between a third and forty percent.

MR. KUCHENBECKER: All right, thank you.

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MR. LASSITER: I have a couple of questions I would like to ask Mr. Fath first.

You mentioned that in your experience with employee deaths, you had about 20 deaths out of 1,000, none of which were attributed to angiosarcoma.

Do you feel that this finding is of a statistical significance when compared to the experience of the risk of angiosarcoma in the male population or the adult population of the United States?

That is, this number of risk compared to what we normally see ... about 25 per the U. S. population?

MR. FATH: If I understand your question, Dr. Lassiter, we're saying that we have had no such deaths out of our population of 1,029?

MR. LASSITER: Yes, I am wondering if you consider this a statistical significance in view of the rate that we normally see in the United States that has been reported?

MR. FATH: I would suspect that both the number zero and the number 1,029 are too small in making any statistical conclusions.

We are simply stating the fact that in that worker population, our operation has not experienced any of these deaths.

MR. LASSITER: Thank you.

I was particular interested by your testimony as

opposed to area monitoring.

Would you feel that perhaps that area monitoring, backed up by personal monitoring, would be something that would be giving a picture of individual exposure? Realizing that the point that you raise, that perhaps area monitoring, if properly applied, can do this; but do you feel that perhaps personal monitoring may be required to establish this type of area monitoring before it can be relied upon?

MR. FATH: If I may reply to the question and perhaps a period of time in which area monitoring would be backed up by personal monitoring, and perhaps the burden of the person monitoring might be phased out if there is satisfactory data available, that the two indeed coincide in what is represented as an exposure in the plant, then I certainly see no harm in accumulating additional data.

I would hope that with enough experience in the monitoring, in the area of monitoring work, that it can be demonstrated that immediately or eventually that personnel monitoring is redundant and that therefore that particular analytical chore might be removed from the plants.

MR. LASSITER: Do you feel that at any time you can completely rely upon only area monitoring?

MR. FATH: We would expect that to be true, but of course not having any direct experience, I don't think that we could make that statement here today.

MR. LASSITER: In just a point of clarification, do you consider a safe threshold the same as a widely acceptable risk threshold? Is this one and the same, or are we talking about two different thresholds here?

That is,a safe threshold as opposed to a widely acceptable risk threshold?

MR. FATH: I think the two concepts are alternate concepts.

The most desirable, of course, would be to establish a safe threshold in which one can have scientific confidence.

MR. LASSITER: Would you have anything that you could tell us about what would constitute a widely accepted risk threshold as to who this would be acceptable to, for example?

MR. FATH: Well, I think that is really the key of these deliberations here. I would expect that the Secretary's and his decision in this matter, will represent the widest publicly accepted risk threshold when that decision is finally made.

MR. LASSITER: You would leave this decision to the government and expect the government to make this type of decision; is that correct?

MR. FATH: Given the input that we are providing at this point, yes, I think that is the -- .

MR. LASSITER: Then you would have no guidance to

give as to what you consider a widely accepted risk threshold, is that correct?

MR. FATH: Well, the guidance that we have given represents one of maximum feasibility and we have given that in the unfortunate absence of conclusive data which I believe all interested parties concur. The fact that conclusive data are unfortunately not with us in the timespan required to make decisions.

MR. LASSITER: I am not going to push this point, but I would like to see if you would be able, or feel that you can in any way give us some information about what you consider an acceptable risk, and I assume here we are talking about a risk of contracting angiosarcoma.

MR. FATH: We are not in a position to do that.

MR. LASSITER: Thank you.

MR. KLEIN: Thank you very much.

JUDGE MYATT: I was beginning to wonder if there would be any questions left for the rest of you to ask, but I am sure you will surprise me and find a few.

Yes, sir, step up.

MR. CLARK: Dennis Clark of the United Steel Workers.

JUDGE MYATT: You are going to have to speak into that mike.

MR. CLARK: Dennis Clark, counsel for the United

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Steel Workers of America.

I will address this question to Mr. Fath, although he could defer to any member of his panel if he deems it appropriate.

In your various testimony you described your efforts to reduce exposure levels in your existing facilities and also, I believe, you described in your new plant that you are building in Texas.

You made mention of various licenses or trade secrets involved in various technological advances in reducing its exposure levels, is that correct?

MR. FATH: That refers primarily to our new plant which we have the technology, for which we have licensed from the Shinitzu Company in Japan.

MR. CLARK: Licensed from what other company did you say? Or are you the licensor?

MR. FATH: We are the licensee. Licensed from the Shinitzu Company in Japan.

MR. CLARK: I see. Are there -- are those types of license available for the rest of the industry also?

MR. FATH: Yes, they are, to the best of our knowledge.

MR. CLARK: Thank you.

JUDGE MYATT: Yes, sir?

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MR. SAMUELS: Mr. Fath, has your company conducted

any morbidity studies? That is to say, sickness among existing employees and former employees?

MR. FATH: Yes, we have, and in fact we have given the medical examinations as per medical protocol within recent weeks to our employees.

MR. SAMUELS: Do you have any results at this time to give us or --

MR. FATH: We do not have results to give you at this time, but the results are being compiled by the examining authorities.

MR. SAMUELS: And I presume that you would provide it to the Government and for the record, if possible, for this hearing?

MR. FATH: They can be made available when they are completed.

MR. SAMUELS: I believe you said that you needed, in order to reach ten parts per million at all plants, two years; is that correct?

MR. FATH: That is correct.

MR. SAMUELS: Is there no difference, then, between the ability to meet this goal by the location and age of the plant?

MR. FATH: If I understand the question correctly, Mr. Samuels, the newest plant currently under construction, I've indicated, might be able to meet that standard before the

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two years. However, we will only know that once we operate.

MR. SAMUELS: But in general you would expect that newer plant in the south, where they might be open, open plants might be of a year's period of time?

MR. FATH: Not wishing to speak for other technologies, I don't think you can necessarily draw that conclusion because while that location favors lower levels, the quality of the engineering and frankly the type of the product produced, also has considerable influence.

Let me add there that as I indicated, we manufacture some 36 different resins. Our new plant in Texas will produce only three of these types.

Therefore, other technologies, whether they are located north, south, or elsewhere, are not subject to the same engineering skills and improvements as that particular plant is.

MR. SAMUELS: I see. But in general you would, would you subscribe to the concept that the fewer the reactors, the larger the reactors that might be outdoors, plus supplying reactors with monomer by pipeline, these are factors which reduce and make more feasible the reaching of any level.

MR. FATH: That is indicated, yes.

MR. SAMUELS: I have a question for Mr. Lobo, but

perhaps you might want to refer to someone else in your panel.

I referred to you because you mentioned that the capital expenditures would be $10 million.

Is this for all plants plus the contemplated expansion in Pasadena?

MR. LOBO: Yes, this is our very preliminary guess, what the capital requirements might be to reach the ultimate level that we can get to by 1976.

MR. SAMUELS: So it is not based on a hard cost data?

MR. LOBO: That is correct.

MR. SAMUELS: Okay.

Now, you have broken this down by plants, or you just had a gut feeling that it was all the plants involved?

MR. LOBO: No, it has been broken down by plants, again, based on our best estimate at this time.

MR. SAMUELS: Given the current price of resin, I don't know what you charged ing. Yesterday, one of the fabricators said he was paying 35 cents a pound. Can I ask you currently what your prices are?

MR. FATH: Certainly. I believe the reference yesterday to 32 cents a pound was referred to plasticol for resin, which is of a different type and more costly to produce.

Our general-purpose resins, our current price is 17 cents a pound.

MR. SAMUELS: Now, looking at this $10 million capital expenditure, and I realize that there are other costs, labor costs, et cetera; looking at it, could you calculate this cost as a percentage of the sales price of the resin which you just established -- did I hear you right -- you said 17 cents?

MR. FATH: Yes.

MR. SAMUELS: What percentage of the sales price would this capital expenditure constitute, roughly?

MR. FATH: I believe it can be calculated, but it depends conr how many pounds.

MR. SAMUELS: How many pounds do you --

MR. FATH: I don't think one can come up with any single percentage figure.

Let us also include here, the ten was upward of ten. We are not currently sure that that particular number is a high enough number. It is an order of magnitude number that we are quite convinced will not go below; we may go substantially above.

MR. SAMUELS: Would you hazard a guess about a range? [illegible] for a single cost?

MR. FATH: That is entirely dependent upon the final standards that will be issued, because that number and any

range associated with it relates to our final number of ten parts per million.

MR. SAMUELS: That is right. I mean, given the ten parts per million, I am trying to find out, get a feel for what this costs.

MR. FATH: The ten might be twenty.

MR. SAMUELS: The ten might be twenty?

MR. FATH: Yes.

MR. SAMUELS: And if it were $20 million, you wouldn't want to supply for the record what percentage of the sales price that might be?

I will be very specific as to why I am asking these questions. There is another Arthur D. Little report. It is EPA Document called Economic Analysis of Proposed Effluent Guidelines for the Plastics and Synthetics Industry.

On page 53 of that study, there is an interesting conclusion where they try to calculate the cost of meeting the EPA regulations. They said the cost is the percentage of sales of only 1.3 percent. They said, "We believe" -- I am quoting -- "that this would not have any impact on the industry."

So of course we are trying to find out whether the cost of control, the ten parts per million or one part per million would be in that neighborhood.

Do you have any thoughts?

MR. FATH: Well, nowheres in our testimony--and I would like to reiterate this--have we been guided by those economic considerations. That is to say, we believe in investing the necessary funds to reach the most feasible--the lowest feasible level.

So, we have not taken that consideration into account in coming up with lowest technologically feasible levels.

MR. SAMUELS: Thank you.

MR. COTTINE: Mr. Fath, do I understand your testimony correctly that there is a new facility under construction and another facility under expansion, or is there only one facility that is being developed?

MR. FATH: There is only one facility under construction.

MR. COTTINE: And that is the Houston facility?

MR. FATH: Yes.

MR. COTTINE: When did your engineering planning commence for that particular facility? The year.

MR. FATH: I believe it was 1972.

MR. COTTINE: When was the design and operational program completed? In other words, that study and final plans completed.

MR. FATH: Well, we broke ground in August of last year, 1973.

MR. COTTINE: August of '73. Did you make

any modifications on the basis of the old Maltoni experimental data as to the control techniques that you would use with respect to this VCM?

MR. FATH: Well, as I indicated, we would expect to meet the 10 ppm maximum in the operation of that plant within a reasonable time. Since those levels are so considerably below anything either the Viola or the Maltoni studies showed at that time, that was not a vital consideration.

MR. COTTINE: So, you did not consider the studies at that time and no modifications were made; is that correct?

MR. FATH: At that time the state of knowledge was such that the 450 ppm level was the lowest one.

MR. COTTINE: If indications were such at 10 ppm there was a carcinogenic response, would that prompt a renewed consideration of the controls there?

MR. FATH: If I understand you, if that had been at the time we probably wouldn't have gone and expanded our business.

MR. COTTINE: How has your monitoring progressed over the past two or three years? Has it been in steps, or what would you consider the milestones?

[Continued on page following.]

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This is monitoring sensitivity.

MR. FATH: Yes, of course we have only instituted the personal monitoring since the issuance of the temporary standard, so we don't have a two to three year history.

The general history that we have is somewhat qualitative in nature. Using odor levels as an order of magnitude, and I guess we have heard a lot of discussion on that subject, we have had essentially no odor levels in our plants in many recent years that we have operated.

MR. COTTINE: So any sensitivity would be based just extensively on the odor level. You can't describe your monitoring process from 250 parts per million down to 50 parts per million or the like?

MR. FATH: Not -- not backwards of the first part of this year, that is right.

MR. COTTINE: Was there some period? I asked in two or three years. Was this a period where there is a breakthrough?

MR. FATH: No, we cannot tell you.

MR. COTTINE: All right.

Someone on the panel discussed the fact that there were levels of VCM in the office. What was the highest level, and what are the average levels that you found in those office sites?

MR. SCARITO: I believe that was part of my

testimony.

The average levels, I would say, run between one and two. The highest level that I can recall seeing there would be about seven or eight, perhaps nine. Very occasionally -- that's about all I can tell you.

MR. COTTINE: Okay, that is one or two ppm?

MR. SCARITO: Yes, that is correct.

MR. COTTINE: Have your facilities been inspected by any governmental agency for vinyl chloride exposure within the past six months?

MR. FATH: OSHA.

MR. COTTINE: OSHA or perhaps local enforcement authority?

MR. SCARITO: Yes, we were inspected on June the 10th and 11th.

MR. COTTINE: By OSHA?

MR. SCARITO: By OSHA.

MR. FATH: Also by EPA.

MR. COTTINE: By EPA?

MR. FATH: Yes.

MR. COTTINE: I assume that both of those inspections involved VCM monitoring; is that correct?

MR. FATH: Yes, that is.

COTTINE: What were the results of that monitoring conducted by these two agencies?

In terms of levels.

MR. FATH: Right. The EPA data, I don't believe, are published as yet.

MR. COTTINE: You haven't received it?

MR. FATH: No, our informal understandings are that the parimeter lines are one part per million or below. We do have the data for our Pasadena monomer, they are on the order of .3 parts per million.

MR. COTTINE: And the OSHA inspection, have you received the sample data sheets back on those?

MR. FATH: No, we have not. We have had extensive inspection of our own data and records.

MR. COTTINE: I assume in response to the other response, it will be submitted for the record?

MR. FATH: Certainly.

MR. COTTINE: Would you also submit the OSHA and EPA monitoring levels?

MR. FATH: We will be glad to when they are received.

MR. COTTINE: Obviously you have a monitoring program. Do you have a medical surveillance program?

MR. FATH: We do.

MR. COTTINE: Have you established any ppm levels or goals recently, since the establishment of the emergency temporary standard?

MR. FATH: Well, we certainly established the emergency temporary standard as an operational procedure. If I understand your question.

MR. COTTINE: Okay. And therefore what was your goal prior to that time?

MR. FATH: I don't believe we addressed ourselves to that particular problem of goal prior to that time. Since the goal was not set, for us.

MR. COTTINE: Now, with respect to the medical surveillance program, how did you employ the experimental data on the carcinogenicity of vinyl chloride in the medical surveillance protocols that you developed, or did you?

MR. FATH: We did not develop our own protocols, but are rather following in the protocols established in the standards.

MR. COTTINE: So you have no medical surveillance protocol prior to the standards?

MR. FATH: I didn't say that. And I don't think you asked that.

I think you asked, if I understood it, how we developed the current medical surveillance protocol.

And that was on the basis of the guidance we received from the published protocol.

MR. COTTINE: All right, now prior to the adoption of the emergency temporary standards, you did have a medical

surveillance protocol, did you not?

MR. FATH: We had medical examinations for employees that came on board, and you might call it the ordinary physical examinations that are consistent with industrial hygiene practice, not addressing itself to this special problem.

MR. COTTINE: Okay, so, in summary, then, you had a medical surveillance protocol, but it was not specific to liver dysfunction amongst the workers whowere exposed to VC?

MR. FATH: That is correct.

MR. COTTINE: Would you submit your current medical protocol for the record?

MR. FATH: Well, we would be glad to, but I think it would be a duplication of that which is in print, since it is, in fact, no different than that which has been published.

MR. COTTINE: I think it would be helpful just to see what the protocol was.

JUDGE MYATT: Go to your next question, Mr. Cottine.

MR. COTTINE: How many Tenneco plants will be covered by the OSHA permanent standards for VCM?

MR. FATH: That depends upon the final complexion of the standard. We will have three plants for VCM and PVC manufacture. We have another three plants for vinyl processing, and depending on the outcome of the deliberations

in line with the suggestions for proposals to eliminate these, it will either be three or six.

MR. COTTINE: Okay. How many of these plants will be forced to close down if the proposed standard is in fact adopted by the Secretary of Labor?

MR. FATH: Well, as I indicated in the options that we have, if we close down the three resin plants, then the three processing plants would be closed down for lack of product.

MR. COTTINE: But if you could otherwise be supplied PVC resins, your other plants could comply with the proposed standards?

Let me rephrase that.

If you had a supply of PVC resins --

MR. FATH: Without manufacturing --

MR. COTTINE: Right, would your other plants still be capable of complying?

MR. FATH: I believe so.

MR. COTTINE: Fine, thank you.

JUDGE MYATT: Any other questions?

[No response.]

JUDGE MYATT: Thank you, gentlemen.

The Dow Chemical people, I told you that I hoped that we would get to you. I seriously doubt it.

This was scheduled for an hour, and it took roughly

two hours.

At the rate we are going, I don't guarantee it, gentlemen.

We are going to take a recess.

[Short recess.]

JUDGE MYATT: As I previously advised you, there will be changes made in the schedule, and we are going to make one right now.

We are going to have Dr. Peters of Harvard School of Public Health, who has a very short statement.

Notice that, please, Mr. Solicitor, in your examination; a very short statement to read.

He will then be subject to questions.

As soon as he concludes, and as soon as the questions are finished, we will take Air Products.

Proceed, Dr. Peters.

A VOICE: If I may, Your Honor, raise one point.

We were not expecting another medical witness now, in view of the scheduling, and frankly did not have long medical materials for cross-examination.

Obviously we will do the best we can --

JUDGE MYATT: Fine. That is all we want you to do.

Your objection is noted. Overruled.

A VOICE: I would like to associate myself with that.

July 29, 1974

Mr. Jules Jimeno
Occupational Safety and
Health Administration
Docket OSH-36
Room 230
1726 M Street, N.W.
Washington, D. C. 20210

Dear Mr. Jimeno:

Re: Request to Correct Vinyl Chloride
Hearing Transcript

From a review of the transcript of Tenneco Chemicals, Inc.'s testimony at OSHA's vinyl chloride hearing we found that the court reporter reversed pages 700 and 701, thus making incomprehensible a portion of Dr. Lobo's direct testimony. We hereby request that you correct the transcript to reverse the order of the pages which are numbered 700 and 701, and to change their numbers.

We have also found a number of other errors in the transcript, and we request that each of these errors be corrected in order that the transcript will accurately reflect the Tenneco testimony. The other errors to be corrected are:

(1) Page 688, line 22: "Burlinton" should read "Burlington"

(2) Page 691, line 7: "The result" should read "This result"

(3) Page 692, line 17: "recognizes" should read "recognize"

(4) Page 693, line 25: "-or" should read "for"

(5) Page 698, line 21: "reasons" should read "reason"

(6) Page 699, line 2: "rank care" should read "tank car"

(7) Page 699, line 8: "ofVCM" should read "of VCM"

(8) Page 700 (presently numbered 701), line 19: "ofa" should read "of a"

(9) Page 716, line 22: "what ppm?" should read "one ppm."

(10) Page 717, line 2: "ovameter" should read "OVA meter"

(11) Page 722, line 1: "disperse the" should read "disperse in the"

(12) Page 722, line 15: "employees and" should read "employees, then"

(13) Page 722, line 17: "samples, this" should read "samples. This"

(14) Page 723, line 9: "tenth part" should read "ten parts"

(15) Page 724, line 4: "It is normal construction times." should read "That is normal construction time."

(16) Page 724, line 13: "that over a number of our resins would" should read "that in a number of our resins we would"

(17) Page 725, line 20: "in the waiting zones" should read "in the breathing zones"

(18) Page 726, line 4: "levels of proposed" should read "levels wo proposed"

(19) Page 728, line 16: "that it had" should read "that they had"

(20) Page 730, line 14: "so-called can pumps" should read "so-called canned pumps"

(21) Page 730, line 23: "here is of the" should read "here is the"

(22) Page 730, line 24: "dryer out from which" should read "dryer which"

(23) Page 730, line 25: "testimony previously" should read "testimony but previously"

(24) Page 731, line 11: "air pressure." should read "air present."

(25) Page 732, line 11: "to carbons" should read "to carbon"

(26) Page 733, line 7: "licensed practice," should read "licensed process,"

(27) Page 734, line 3: "monomer contact" should read "monomer content"

(28) Page 735, line 3: "maximum referred" should read "maximum TWA referred"

(29) Page 735, line 6: "maximum." should read "maximum TWA."

(30) Page 736, lines 2-3: Delete sentence "Made to wear respirators."

(31) Page 737, line 16: "this a statistical" should read "this of statistical"

(32) Page 737, line 19: "are small" should read "are too small"

(33) Page 737, line 25: "particular" should read "particularly"

(34) Page 738, line 1: "opposed to" should read "it refers to"

(35) Page 738, line 9: "question and" should read "question as"

(36) Page 738, line 12: "the person monitoring" should read "the personnel monitoring"

(37) Page 738, line 17: "area of monitoring" should read "area monitoring"

(38) Page 738, line 18: "demonstrated that immediately" should read "demonstrated immediately"

(39) Page 739, lines 16-17: "I would expect that the Secretary extend his decision" should read "I would expect that Secretary Stender's decision"

(40) Page 740, line 5: "data which" should read "data with which"

(41) Page 741, line 11: "its culture levels," should read "its exposure levels,"

(42) Page 741, line 13: "which we have the technology, for which we have licensed" should read "for which we have licensed the technology"

(43) Page 741, line 14: "Shinitzu Company" should read "Shinetsu Company"

(44) Page 741, line 18: "Shinitzu Company" should read "Shinetsu Company"

(45) Page 743, line 22: "with monitored pipeline," should read "with monomer by pipeline,"

(46) Page 744, line 19: "what we are" should read "what you are"

(47) Page 744, line 23: "pound was referred to plastics for" should read "pound referred to plastisol"

(48) Page 745, line 20: "convinced will" should read "convinced we will"

(49) Page 747, line 1: "nowheres" should read "nowhere"

(50) Page 747, line 17: "engineering plant" should read "engineering plans"

(51) Page 747-A, line 5: "million maximum" should read "million TWA maximum"

(52) Page 747-A, line 7: "old or the" should read "old or the new"

(53) Page 748, line 6: "Using older levels" should read "Using odor levels"

(54) Page 748, line 8: "no older levels" should read "no odor levels"

(55) Page 748, line 11: "the older level." should read "the odor level."

(56) Page 749, line 8: "Have you facilities" should read "Have your facilities"

(57) Page 750, line 6: "the parameter lines" should read "the perimeter lines"

(58) Page 750, line 7: "monomer, they" should read "monomer plant, they"

Please inform me whether the corrections listed above will be made in the transcript.

Sincerely yours,

Allan J. Topol
Counsel for
Tenneco Chemicals, Inc.

emf

bcc: Mr. Joseph Fath
George S[illegible]int, Esq.
J. T. Smit[illegible].

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